Gatekeepers and Self-Preferencing: Incentives and Welfare Trade-offs in Two-sided Markets*

Francesco Decarolis†& Muxin Li‡

Abstract

We study a two-sided platform where a dominant gatekeeper supplies both a primary product and a competing ancillary service. By degrading outcomes for users of rival ancillary services, the gatekeeper engages in cross-market self-preferencing. Our theoretical model identifies when such behavior raises or lowers welfare, depending on buyers' and sellers' preferences and the platform's pricing instruments. Analyzing a recent antitrust case against Google, we show that remedies targeting only one side can misalign incentives between different user groups, reducing welfare. Counterfactual simulations highlight when alternative behavioral or structural interventions realign incentives and improve market efficiency.

Keywords: Multi-Sided Market, Self-Preferencing, Antitrust Regulation, Digital Advertising.
JEL Codes: L21, L40, L51.

---

*Previously circulated under the title "Dominating Ancillary Product Markets via Self-Preferencing." We are grateful for the comments received from Heski Bar-Isaac, Joan Calzada, Christoph Carnehl, Alexandre de Cornière, Chiara Fumagalli, Filomena Garcia, Toomas Hinnosaar, Johannes Johnen, Margarita Kirneva, Ester Manna, Jose Manuel Paz y Mino, Massimo Motta, Leon Musolff, Robin NG, Marco Ottaviani, Michele Polo, Andrew Rhodes, Devesh Raval, Miguel Risco, Ksenia Shakhgildyan, Robert Somogyi, Mark J. Tremblay, and the seminar participants at the EODS UPenn symposium 2023, Lisbon Meeting, Digital Economy Workshop at Telecom, CRESSE 2024, EARIE 2024, JEI 2024, Workshop on Recommendation Systems 2025 where preliminary versions of this study have been presented. We acknowledge the financial support of the EODS research grant and the ERC Consolidator Grant "CoDiM" (GA No: 101002867).

†IGIER, Bocconi University, via Roentgen 1, Milan, 20122, Italy. Email: francesco.decarolis@unibocconi.it
‡IGIER, Bocconi University, via Roentgen 1, Milan, 20122, Italy. Email: muxin.li@unibocconi.it

"For over a decade, Google has tied its publisher ad server and ad exchange together through contractual policies and technological integration, which enabled the company to establish and protect its monopoly power in these two markets. ... In addition to depriving rivals of the ability to compete, this exclusionary conduct substantially harmed Google's publisher customers, the competitive process, and, ultimately, consumers of information on the open web." — Judge Leonie Brinkema, *United States v. Google LLC*, April 17, 2025.

1 Introduction

In two-sided markets, users derive value from interacting with each other and often benefit from a growing user base. The network effects enhance the appeal of dominant companies, resulting in market concentration. In addition to their core services, dominant digital platforms (i.e., gatekeepers) have continuously expanded into ancillary service markets (see Athey and Scott Morton (2021) and Heidhues et al. (2024)). These ancillary services often complement the core products offered in the primary market, facilitating transactions between buyers and sellers. For instance, Apple provides electronic payment technologies or subscription channels for iOS developers to interact with mobile users, Amazon offers product storage for sellers to fulfill Amazon orders, and Google supplies multiple complementary technologies to facilitate interactions in the digital advertising market. Although these firms hold dominant market shares in their primary markets, they often face competition in ancillary service markets. However, they can leverage their dominance in the primary market to promote and advantage their own ancillary service—this practice is commonly referred to as *self-preferencing*.

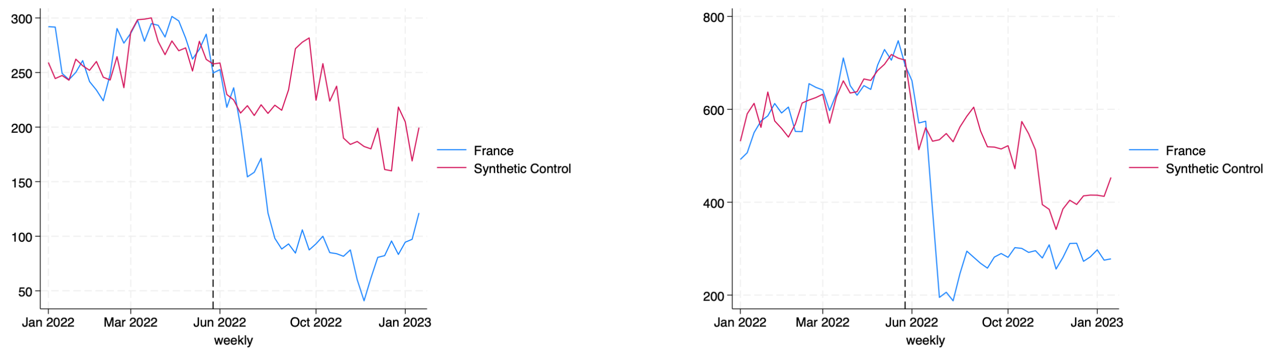
In recent years, self-preferencing has attracted growing regulatory scrutiny. In 2025, the U.S. Department of Justice (DoJ) won a landmark case against Google, ruling that the company had monopolized digital advertising markets by favoring its own advertising technology (adtech) tools. To bar Google from entering or maintaining exclusive contracts, the DoJ then published a series of remedies.[1] Similar practices have prompted enforcement actions in Europe: Apple was fined €1.8 billion by the European Commission (EC) for deterring app developers from advertising cheaper subscription options outside the App Store, and Amazon was required to modify its Buy Box algorithm to prevent it from favoring merchants using Amazon's logistics services. The Digital Markets Act[2] now explicitly prohibits self-preferencing by designated gatekeepers in the European Union (EU), while forthcoming guidelines[3] on exclusionary abuses from the EC are expected to set obligations for

[1] See https://www.justice.gov/opa/pr/department-justice-wins-significant-remedies-against-google.
[2] See https://digital-markets-act.ec.europa.eu/index_en.
[3] See https://competition-policy.ec.europa.eu/public-consultations/2024-article-102-guidelines_en.

dominant firms to avoid such behavior. But despite this regulatory momentum, the economic analysis of self-preferencing—and its broader welfare implications—remains relatively limited.

This paper develops a model of self-preferencing that reflects the key characteristics of such practices and helps explain puzzling evidence emerging from recent antitrust interventions. Indeed, ex post remedies designed to curb self-preferencing have, sometimes, exacerbated the very problems they sought to address. A motivating example is the French Competition Authority's (FCA) 2021 antitrust case against Google, which concluded that the company leveraged its dominant ad server to favor its own supply-side platform (SSP), disadvantaging rival SSPs. As part of the settlement, Google committed to share auction data equally with third-party SSPs—a behavioral remedy intended to level the playing field. However, Figure 1 illustrates that, following the June 2022 implementation of this commitment, publisher revenue and advertiser participation for major domains in France declined markedly compared with a synthetic control group (see Section 4 for details). These findings highlight the unintended consequences and complication of regulating self-preferencing in digital ecosystems.

Figure 1: Display Advertising Market: Pre- and Post-FCA Intervention



(a) Publisher Revenue ($ Thousands)

(b) Number of Advertisers

The dashed line marks June 30, 2022, the deadline set by the FCA for implementing Google's data-sharing commitment.

The core feature of the model builds on a simple but powerful insight: ancillary services needed to complete transactions in the two-sided market are chosen—and often paid for—by sellers, yet the consequences of these choices also affect buyers. In other words, the selection of ancillary services influences the surplus on both sides of the market. The model allows for flexibility, accommodating cases where buyers' and sellers' preferences for ancillary services are either aligned or divergent. Given the complex interplay between primary products and ancillary services, as well as the emergence of novel market features, the underlying mechanisms and trade-offs captured by our model differ substantially from those in existing research, as discussed later.

More specifically, the benchmark model features two user groups—buyers and sellers—who derive value from interacting with each other and have heterogeneous outside options. To enable these interactions, both sides must rely on a primary product supplied by a dominant firm. In addition, sellers must purchase an ancillary service in an adjacent market to complete transactions. While the primary product is monopolized, ancillary services are available both from the dominant firm (*gatekeeper*) and from independent providers. We define *cross-market self-preferencing* as the practice by which the gatekeeper promotes its own ancillary services by reducing the relative profitability of sellers who choose competing alternatives. This can be achieved in several ways—for example, by limiting interoperability between the gatekeeper's primary product and rival ancillary services, restricting competitors' ability to improve their quality, or steering buyers away from sellers that rely on competing offerings. Crucially, although ancillary services are purchased by sellers, they affect the quality and terms of interactions with buyers, thereby influencing their surplus too.

First, we show that the gatekeeper has an incentive to engage in self-preferencing even when its ancillary service is of lower quality than rival offerings—provided its quality is not too low for self-preferencing to remain profitable. This result contrasts with the Chicago School's critique of conventional foreclosure, which argues that dominant firms typically lack incentives to exclude more efficient competitors. We find this result in a benchmark setting without network effects, but we then show that positive network effects can further strengthen the gatekeeper's incentive to self-preference, helping explain why this strategy has become pervasive in today's digital markets.

Self-preferencing allows the gatekeeper to charge a higher price for its ancillary service and gain a larger share of the adjacent market. However, this also raises transaction costs for sellers, discouraging their participation in the primary market. Lower seller participation, in turn, reduces seller demand and diminishes the gatekeeper's profits from the primary product. Thus, self-preferencing remains profitable only when the ancillary service's quality is high enough for the gains in the adjacent market to outweigh the losses from reduced seller participation in the primary market.

Second, the welfare implications of self-preferencing are nuanced and depend jointly on several factors: the relative preferences of buyers and sellers over ancillary services and the gatekeeper's pricing instruments. Notably, when the gatekeeper charges only sellers, its incentive to self-preference can align with sellers' short-run interests. In such cases, sellers actually benefit when self-preferencing is profitable for the gatekeeper. However, the impact on buyers may be negative if they derive lower utility from the gatekeeper's ancillary service compared to rival offerings.

The intuition is as follows: after self-preferencing, each additional seller attracted to the market is more likely to choose the gatekeeper's ancillary service, generating higher profits for the gatekeeper. This incentivizes the gatekeeper to lower the price of the primary product to stimulate seller participation, which in turn benefits sellers. As for buyers, if they value the gatekeeper ancillary service, they are better off, but if they prefer rival ancillary services, they are worse off.

Third, we consider whether regulating self-preferencing is necessary in the long run and, if so, how it could be done effectively. To explore this, we analyze an extreme scenario in which the gatekeeper is allowed to monopolize the ancillary service market. In this case, self-preferencing can produce severe long-run negative effects for both buyers and sellers, demonstrating that oversight and regulation of self-preferencing are essential in digital markets.

Based on the benchmark, we also consider two extensions. First, we examine the role of network effects. Second, we explore how the gatekeeper's access to different pricing instruments affects outcomes. These theoretical results shed light on the earlier evidence from the Google France antitrust case. The FCA's intervention targeted self-preferencing only on the publisher side, without addressing the advertiser side, which pushed publishers toward non-Google technologies that advertisers were less willing to use. As our model predicts, this also reduced Google's incentive to attract publishers after the regulation. Consequently, the FCA remedy lowered the surplus of both buyers and sellers, consistent with the observed outcomes in France. By contrast, the DoJ and EC cases in the same industry take a broader approach—addressing both sides of the market—which aligns with our model's implication that a more comprehensive view is needed to adequately balance incentives.

In the final part of the paper, we illustrate how the model can be applied for empirical evaluation. Using data from the adtech industry, we first offer novel evidence on the ex-post impacts of the FCA intervention and then re-assess policy counterfactual related to it. Our estimates indicate that French advertisers derive roughly ten times more value from publishers using Google's adtech than from those relying on rival technologies. Consistent with the model, we confirm a decline in total welfare following the FCA regulation. However, this welfare loss could have been mitigated by an alternative behavioral remedy targeting Google's restrictions on the advertiser side. Specifically, a modest improvement—less than 1%—in the relative value of third-party adtech for advertisers would have been sufficient to offset the welfare decline. We also consider a structural remedy that separates Google's primary product and ancillary service, and compare it with the FCA's behavioral intervention. Neither approach dominates ex ante: their effectiveness depends on how well they realign incentives and cross-side compatibility. Structural remedies can outperform behavioral ones when they significantly improve the competitiveness of rival adtech for both publishers and advertisers. In our analysis, we find that when the advertiser-side quality gap is reduced by more than 5.49%, divestment yields a net positive welfare effect.

This study makes three key contributions. First, it develops a tractable yet flexible model that captures the fundamental mechanisms and trade-offs driving cross-market self-preferencing, and clarifies conditions under which it arises, its welfare effects, and its response to regulation. Second, it introduces new empirical evidence from a natural experiment in the French adtech market, shedding light on why well-intentioned remedies may backfire. Third, it leverages this framework to run counterfactual simulations, quantifying the welfare implications of alternative behavioral and structural remedies and identifying thresholds under which each becomes effective. Taken together, our findings yield a clear policy message: there is no universally superior remedy for self-preferencing. Effective regulation must recognize the two-sided nature of digital platforms and target both sides of the market simultaneously; otherwise, interventions risk fragmenting the market and reducing overall efficiency. By combining theory, empirical evidence, and counterfactual analysis, this paper offers the first integrated assessment of the welfare implications of self-preferencing in the adtech industry and informs the ongoing debate on how to regulate gatekeepers in digital markets.

The remainder of the paper proceeds as follows. Section 2 develops the model. Section 3 explores extensions including network effects and pricing instruments. Section 4 presents the empirical analysis and counterfactual simulations. Section 5 concludes.

Literature - This paper intersects with four strands of literature. First, it contributes to the research on self-preferencing in digital markets (De Corniere and Taylor, 2014, 2019; Kang and Muir, 2022; Dendorfer, 2024; Motta, 2023), which largely focuses on hybrid-mode platforms.[4] In contrast, we study "cross-market" self-preferencing, where the platform favors its ancillary service by degrading the performance or value of rival services in adjacent markets. This distinction entails different tradeoffs and welfare implications: on hybrid-mode platforms, the platform competes directly with third-party sellers and can extract their surplus by charging referral fees. The platform faces a trade-off between monetizing through referral fees on third-party sales or earning retail margins from its own direct sales. In cross-market self-preferencing settings, however, the former monetization channel is shut down,[5] and, contrary to the existing literature (Anderson and Bedre Defolie, 2024; Zennyo, 2022; Etro, 2023; Padilla et al., 2022), welfare impacts of cross-market self-preferencing no longer hinge on referral fees.

Second, we relate to the literature on tying and bundling in digital markets (Dong and Cong, 2024; De Corniere et al., 2024; Choi and Jeon, 2021; Bisceglia and Tirole, 2023). These works often model

[4]Hybrid-mode platforms both intermediate and sell directly, such as Amazon acting as both marketplace and retailer. Self-preferencing here often involves recommendation bias toward own offers: Zennyo (2022) model inclusion in consumers' consideration sets; Kittaka and Sato (2022) assume platform offers are checked first; Hagiu et al. (2022) consider suppressing innovative sellers.

[5]For example, Amazon cannot charge warehouses storing goods for third-party sellers; Apple cannot extract fees from competing subscription services or payment technologies; Google cannot charge competing adtech providers for interacting with Google's tools in other layers of the adtech stack.

tying as a response to pricing constraints or buyer-side strategies.[6] By contrast, we model a setting where the ancillary service is not tied to the primary product, but sellers using rival ancillary services experience lower performance. This is consistent with empirical features of platforms like Apple, Amazon, and Google, where participation does not strictly require using the platform's complementary services.[7] We also identify a novel mechanism: the divergence between buyers' and sellers' preferences over ancillary services. Unlike traditional models where consumers react directly to bundling, here sellers choose the ancillary service, but buyers experience the outcome. This two-sided inconsistency is central to the model's results and regulatory implications.

Third, the paper contributes to the broader literature on multi-sided markets (Belleflamme and Peitz, 2021; Teh, 2022; Bisceglia and Tirole, 2023; Crawford et al., 2023; Rochet and Tirole, 2004; Jullien, 2005; Biglaiser et al., 2019; Crawford et al., 2023; Bergemann and Bonatti, 2024). Network effects play a central role: our model shows that strong cross-group network effects raise the platform's incentive to self-preference and can reduce the risk of welfare loss.

Lastly, we relate to studies on platform recommendation and search (Hagiu and Jullien, 2011; Inderst and Ottaviani, 2012; Tadelis, 2016; Hunold and Muthers, 2017; Shen and Wright, 2019; Li et al., 2020; Long and Liu, 2023; Ostrovsky, 2023; Gambato and Risco, 2024), and to empirical work on self-preferencing, especially for Amazon (Lam, 2021; Gutiérrez, 2022; Farronato et al., 2023; Waldfogel, 2024).[8]

2 Benchmark Model

This section develops a benchmark model to capture the economic logic of cross-market self-preferencing. The framework is intentionally streamlined so that the core strategic forces—platform pricing, seller choice, and buyer preferences—remain visible. In Section 3 and Appendix, we will enrich this setup by introducing network effects, buyer charging, and other extensions.

[6] See Choi and Jeon (2021) and Bisceglia and Tirole (2023) on how tying circumvents zero pricing limits in final markets.

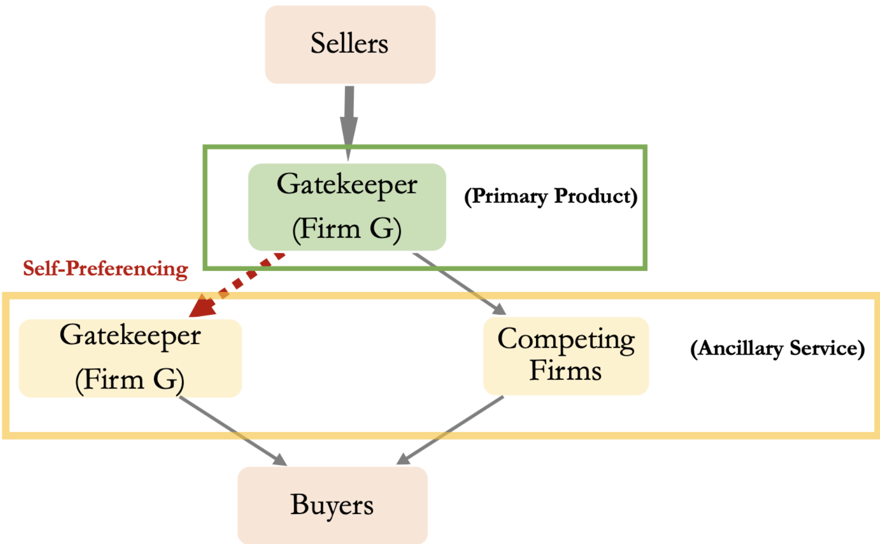
[7] E.g., advertisers using non-Google adtech still reach publishers; iOS developers using Stripe can list on the App Store.

[8] Chen and Tsai (2024) find Amazon products receive more cross-sell exposure; Lee and Musolff (2021) show that Amazon recommendations are price elastic and may increase consumer surplus.

Model Setup

There is a two-sided market where users gain value from interacting with each other. To simplify notations, we refer to one group of users as sellers (he/his) and the other as buyers (she/her). However, the model setup is general and encompasses other market types. For example, in the context of the display advertising market, the two groups transform into publishers (sellers of advertising slots) and advertisers (buyers of advertising slots).

Figure 2: Market Structure



Sellers rely on a primary product to interact with buyers. In addition, they must also purchase an ancillary service in an adjacent market to facilitate interactions. As shown in Figure 2, a gatekeeper, denoted as firm G, sells both in the primary product and ancillary service markets. While the company monopolizes the primary (product) market, it faces competition in the ancillary service market. In addition to firm G, there are also $N \geq 1$ competitive fringe firms selling similar ancillary services. As illustrated in Table 1, this market structure applies to several, recent antitrust cases. Detailed descriptions of these cases are provided in the Appendix.

Table 1: Mapping between Model Setup and Recent Antitrust Cases

Gatekeeper	Buyers	Sellers	Primary Product	Ancillary Service	Self-Preferencing Practice
Google	Advertiser	Publisher	Google DoubleClick	SSP	Interoperability Restrictions
Apple	Mobile Users	App Developers	iOS App Store	Electronic Payment Technology	Marketing Restrictions
Amazon	Buyers	Sellers	Amazon Marketplace	Storage and Shipping	User Steering

Within this market structure, the gatekeeper can practice self-preferencing across markets, leveraging its dominant position in the primary product market to favor its sales in the ancillary service market. To achieve the goal, the gatekeeper firm diminishes the relative value of sellers who use competing ancillary services to facilitate interactions, while making its own ancillary service more favorable. In real markets, gatekeeper firms can employ varied approaches to practice such self-preferencing. These include restricting interoperability between their primary products and competing ancillary services, as Google has been accused of doing in the adtech industry; raising sellers' costs when transacting through rival ancillary services, as Apple has been accused of through marketing restrictions on non-Apple subscription channels; or steering buyers away from sellers using competing services, as Amazon was accused of by biasing recommendations against merchants relying on rival logistics services.

Fringe firms all incur the same entry cost L, and their services have no vertical differentiation.[9] Specifically, we refer to the gatekeeper firm G's ancillary service in the adjacent market as the first-party (1P) service and all other firms' ancillary services as third-party (3P) services. Accordingly, we categorize sellers who use the 1P service as 1P sellers and sellers who use 3P services as 3P sellers. To simplify without loss of generality, we normalize the marginal costs of the primary product and ancillary services to zero throughout the analysis.

A seller has two ancillary services in his consideration set: one is always the 1P service from firm G, and the other is a randomly chosen 3P service. Hence, the probability that any fringe firm $k \in \{1,2,...,N\}$ is included in the seller's consideration set equals $1/N$. In Appendix, we relax this assumption and analyze the scenario where all services in the consideration set are chosen randomly. In this case, fringe firms not only compete with the gatekeeper firm but also with each other. We show that the conclusions drawn in this market are qualitatively similar to those in the benchmark.

A seller perceives the two ancillary services in his consideration set as both vertically and horizontally differentiated. Vertical differentiation is modeled by sellers' diverse profits/values when they use different ancillary services to fulfill interactions with buyers. If sellers choose the 1P service, their profit from joining the market is denoted as v_G^s. However, if sellers choose a 3P service from a competing firm, their profit is denoted as $v_k^s = v_G^s - \beta_s$. The parameter β_s measures the vertical difference between the two ancillary services for sellers. Its value can be either positive, zero, or negative. If 1P sellers derive a higher profit from joining the market than 3P sellers, then $\beta_s > 0$. Otherwise, it is the opposite.

Horizontal differentiation is modeled in the Hotelling fashion. As shown in Figure 3, the two ancillary services are located at the two ends of a unit-length Hotelling line, with the 1P service located

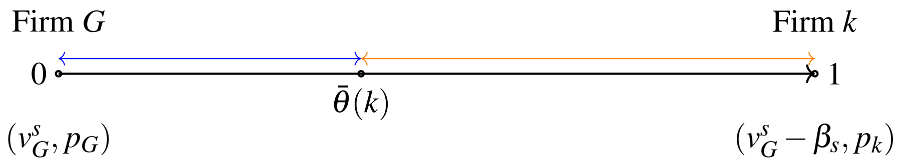
[9] This entry cost is not collected by firm G.

at 0 and the 3P service located at 1. Sellers are uniformly distributed on this Hotelling line and incur the cost of not having one's ideal ancillary service that linearly increases in distance at rates t. Within this setup, the surplus of seller j, who has fringe firm k in his consideration set and purchases the ancillary service from firm $i \in \{G,k\}$, is given by

$$U_s(\theta_j, i) = v_i^s - p_i - m_S - t|\theta_j - l_i|,$$

where $\theta_j \in [0,1]$ is the position of seller j, $l_i \in \{0,1\}$ represents the location of firm i, m_S is the primary product price, and p_i denotes the corresponding ancillary service price.

Figure 3: Hotelling Line



Although sellers are the ones who choose and pay for the ancillary services, their choices are later used to facilitate interactions with buyers. Thus, the selection of ancillary services affects not only the profit of sellers but also the surplus of buyers. Specifically, buyers' utility is denoted as v_G^b if sellers use the 1P service to fulfill interactions and as $v_C^b = v_G^b - \beta_b$ if sellers employ 3P services. The parameter β_b measures the vertical difference between the two ancillary services for buyers. If $\beta_b = 0$, buyers are completely indifferent among all sellers. If $\beta_b > 0$ ($\beta_b < 0$), buyers expect a higher (lower) utility from 1P sellers than from 3P sellers. There is no correlation between β_b and β_s, meaning that the preferences of buyers and sellers for ancillary services can either differ or be identical. In summary, a buyer's total expected utility from joining the market is given by

$$U_b = \begin{cases} v_G^b, & \text{if 1P service} \\ v_G^b - \beta_b, & \text{if 3P service.} \end{cases}$$

The timeline of the game is as follows: First, firm G sets its price in the primary market and in the adjacent market. Second, fringe firms simultaneously choose the prices of their own ancillary services.[10] Given the prices in the primary and adjacent markets, buyers and sellers make entry decisions. Last, sellers who join the market purchase the ancillary service that gives them the highest value. Based on sellers' choice of ancillary services, buyers and sellers realize corresponding surpluses

[10] The market will converge to the same equilibrium if the first two steps occur simultaneously.

in the market. To prevent trivial market equilibria in the analysis, we make the following assumptions, with the explicit equations for all cutoff values provided in the Appendix.

Assumption 1. *In the benchmark model, we assume that:*

- ***[Positive Demand]*** *the ancillary service values satisfy* $|\beta_s| < 3t$ *so that both the 1P service and 3P service derive a positive demand at equilibrium;*
- ***[Competitive Market]*** *the surplus is sufficiently large* $v_G^s > \tilde{v}_G^s$*, such that there exists competition between the 1P service and 3P services; and*
- ***[Market Participation]*** *the surplus satisfies* $\underline{v}_G^b < v_G^b < \bar{v}_G^b$ *and* $\underline{v}_G^s < v_G^s < \bar{v}_G^s$*, so that user entry does not hit corner solution.*

Our benchmark setup focuses on a simple setting to highlight underlying mechanisms. Several extensions and robustness checks are provided in the later sections and the appendix. First, the benchmark abstracts away the cross-group network effects. In other words, a user's surplus—both on the buyer side and the seller side—is not influenced by the participation of the other group. Such network effects are incorporated into the model in Section 3, where we investigate the influence of network effects on self-preferencing incentives and its welfare implications. Second, in the benchmark, we assume that buyers enjoy free services to facilitate their interactions. This assumption is inspired by the observations that many companies, such as Amazon's Marketplace and Apple's App Store, offer free intermediation services for buyers. We relax this assumption in Section 3, where we examine the market outcomes when the gatekeeper charges both buyers and sellers.

Several other extensions are documented in the Appendix. In particular, we consider the case of horizontal differentiation between the 1P and 3P services to be affected by firms' entry into the adjacent market (Appendix B.2), exploring fully random consideration set (Appendix B.3), relaxing the uniform distribution of outside options (Appendix B.4), investigating alternative self-preferencing definition (Appendix B.5), and relaxing the assumption that the gatekeeper firm takes the market size as given when determining 1P service (Appendix B.6). Also, in the main text, we abstract away the transactions between buyers and sellers. In Appendix B.7, we incorporate this transaction stage between buyers and sellers and highlight similar underlying mechanisms to the benchmark.

Market Equilibrium

We next proceed to solve for the subgame perfect equilibrium. We initiate the analysis by examining sellers' demands for ancillary services, as well as the demands for the primary product on both sides of the market. We then investigate firms' pricing decisions in the adjacent market, followed by an exploration of firm G's profit-maximizing pricing strategy in the primary market.

Seller Demands If firm G and firm $k \in \{1,2,...,N\}$ are in a seller's consideration set, the seller is indifferent between the two firms when his location $\bar{\theta}(k)$ satisfies $U_S(\bar{\theta}(k),G) = U_S(\bar{\theta}(k),k)$. Solving this equation, we derive the indifferent seller's location as follows:

$$\bar{\theta}(k) = \frac{\beta_s + p_k - p_G + t}{2t}.$$

As illustrated in Figure 3, sellers located at $\theta_j < \bar{\theta}(k)$ will purchase from firm G, while the rest will choose firm k. Given that fringe firms have an equal probability of being included in a seller's consideration set, the fraction of sellers considering firm k is n_s/N. As for firm G, it is considered by all sellers, regardless of their consideration sets. Therefore, the demands for the two ancillary services can be expressed as:

$$Q_G = \sum_{k=1}^{N} \bar{\theta}(k)\frac{n_S}{N} = \sum_{k=1}^{N} \frac{(\beta_s + p_k - p_G + t)}{2t}\frac{n_S}{N},$$
$$Q_k = \left(1 - \bar{\theta}(k)\right)\frac{n_S}{N} = (1 - \frac{\beta_s + p_k - p_G + t}{2t})\frac{n_S}{N},$$

where Q_G represents the demand for the 1P service, and Q_k denotes the demand for firm k.

Motivated by the intricate rules governing digital markets, we assume that sellers become aware of their consideration set and their specific location on the Hotelling line *after* joining the market. This corresponds to the idea that app developers may not charge subscription fees until they build a loyal user base, or sellers on Amazon may not consider their storage choice until they receive several orders. It is only after a seller joins the market and understands how the ancillary service works jointly with the primary product that he becomes aware of his preferences. In such a context, a seller's expected surplus from joining the market, denoted as $E[U_s]$, equals:

$$E[U_s] = \sum_{k=1}^{N} \left(\int_0^{\bar{\theta}(k)} (v_G^s - p_G - tx)dx + \int_{\bar{\theta}(k)}^{1} (v_G^s - \beta_s - p_k - t(1-x))dx \right) \frac{1}{N} - m_S.$$

As for buyers, their expected utility depends on the distribution of sellers among ancillary services and can be written as:

$$E[U_b] = \sum_{k=1}^{N} \left(\int_0^{\bar{\theta}(k)} v_G^b dx + \int_{\bar{\theta}(k)}^1 (v_G^b - \beta_b) \right) \frac{1}{N}.$$

Users in both groups will join the market if they expect to derive a higher surplus than their outside options. Without loss of generality, we assume that both buyers' and sellers' outside options follow a uniform distribution in the interval $[0,1]$, and their user sizes are normalized to one.[11] Within this model setup, the primary product market participation in both groups are given by: $n_S = E[U_s]$ and $n_B = E[U_b]$.

Firm Pricing Given the demand functions, we now investigate firms' pricing strategies in the ancillary service market. For fringe firm k, its profit comes solely from selling ancillary services and can be calculated as:

$$\pi_k = p_k Q_k - L = p_k \frac{(-\beta_s + p_G - p_k + t) n_S}{2Nt} - L.$$

As for firm G, it earns additional profit from providing the primary product. Accordingly, its profit is expressed as:

$$\pi_G = m_S n_S + p_G \sum_{k=1}^{N} \bar{\theta}(k) \frac{n_S}{N} = m_S n_S + \sum_{k=1}^{N} p_G \frac{(\beta_s - p_G + p_k + t) n_S}{2Nt}.$$

As illustrated in the previous analysis, sellers' demand for market participation is jointly determined by all firms in the ancillary service market. To simplify, we assume each firm in the ancillary service market has minimal impact and takes the aggregate demand n_S as given.[12] At the symmetric equilibrium, the ancillary service prices are given by:

$$p_G = t + \frac{\beta_s}{3}, \quad (1)$$

$$p_C = t - \frac{\beta_s}{3}, \quad (2)$$

[11]The relaxation of this assumption does not affect the main conclusion, as discussed in the Appendix.

[12]In the Appendix, we relax this assumption and find qualitatively similar key findings.

where p_C represents the price set by all fringe firms at the symmetric equilibrium.

Plugging in the equilibrium prices, the ancillary service demands are equal to:

$$Q_G = (\frac{1}{2} + \frac{\beta_s}{6t})n_S, \quad (3)$$

$$Q_C = (\frac{1}{2} - \frac{\beta_s}{6t})\frac{n_S}{N}, \quad (4)$$

where Q_C denotes the demand for each fringe firm at the symmetric equilibrium. Accordingly, the equilibrium ratio of sellers choosing the 1P service is denoted as $q_G = Q_G/n_S = \frac{1}{2} + \frac{\beta_s}{6t}$.

Primary Product Pricing Lastly, we analyze firm G's pricing strategy over its primary product. Given the ancillary service prices (expression 1-2) and demands (expression 3-4) at equilibrium, the explicit demands for market participation can be expressed as:

$$n_B = v_G^b + \frac{\beta_b(\beta_s - 3t)}{6t},$$

$$n_S = \frac{\beta_s^2 - 18\beta_s t - 36tm_S - 45t^2 + 36tv_G^s}{36t}.$$

Maximizing firm G's profit by solving the first-order condition, we derive the profit-maximizing price in the primary market as:

$$m_S^* = \frac{36tv_G^s - \beta_s^2 - 30\beta_s t - 63t^2}{72t}. \quad (5)$$

Given the equilibrium pricing strategies, the demands for the primary product are given by:

$$n_B^* = \frac{\beta_b\beta_s + 6tv_G^b - 3\beta_b t}{6t}, \quad (6)$$

$$n_S^* = \frac{\beta_s^2 - 2\beta_s t - 9t^2 + 12tv_G^s}{24t}, \quad (7)$$

and the resulting demands for ancillary services are $Q_G^* = (\frac{1}{2} + \frac{\beta_s}{6t})n_S^*$ and $Q_C^* = (\frac{1}{2} - \frac{\beta_s}{6t})n_S^*$.

We lastly calculate the equilibrium profits of firms and derive:

$$\pi_G^* = \frac{(\beta_s^2 - 2\beta_s t - 9t^2 + 12tv_G^s)^2}{576t^2}, \tag{8}$$

$$\pi_C^* = \frac{(3t-\beta_s)^2(\beta_s^2 - 2\beta_s t - 9t^2 + 12tv_G^s)}{432Nt^2} - L, \tag{9}$$

where π_C^* denotes the profit of each individual fringe firm at the symmetric equilibrium.

In summary, the market equilibrium in the benchmark can be summarized as in Proposition 1:

Proposition 1. *Under Assumption 1, there is a unique equilibrium such that a total of n_B^* buyers and n_S^* sellers, as shown in equations (6) to (7), join the market. Among them, a portion of $(3t+\beta_s)/6t$ opts for 1P services, while a proportion of $(3t-\beta_s)/6t$ chooses 3P services at the subgame-perfect equilibrium. The fringe firms and firm G choose the pricing strategies listed in expression (1)-(2) and (5), leading to the profits as shown in equations (8)-(9).*

Self-Preferencing Impact

Based on the market equilibrium, we now examine the impact of self-preferencing. In real markets, self-preferencing may drive a larger portion of transactions to be fulfilled by the gatekeeper's own ancillary service, but it does not affect the overall volume of transactions or interactions in the market. In this context, sellers' surplus from using the 1P and 3P services can be written as $v_G^s = (v^s + \beta_s)/2$ and $v_k^s = (v^s - \beta_s)/2$, where $v^s = v_G^s + v_k^s$ denotes the fixed total profit or surplus associated with the 1P and 3P services. In the Appendix, we relax this assumption and reach qualitatively similar conclusions.

Also, to avoid the detections by competition authorities, gatekeepers typically implement marginal adjustments rather than substantial changes. Accordingly, we focus on how the market evolves when there is a slight reduction in sellers' relative value of 3P services compared to 1P services. Mapping such an adjustment to our model, self-preferencing is represented by a marginal increase in β_s, and we analyze its impact by studying corresponding comparative statics. All proofs are provided in the Appendix.

As shown in Equations (1-2), the 1P and 3P ancillary services have the same price when there is no vertical differentiation for sellers. The introduction of vertical differentiation, β_s, lowers the price of 3P services by $\beta_s/3$ while raising the 1P service price by $\beta_s/3$. If the gatekeeper firm practices self-preferencing, the 1P service becomes relatively more attractive, i.e., β_s increases. Hence, in the adjacent market, the 1P service price increases, while the price of 3P services decreases.

In the primary market, firm G diminishes its product price following self-preferencing. This is because the 1P service becomes more expensive after self-preferencing, making it more costly for sellers to fulfill transactions in the market. As a consequence, sellers' entry is discouraged, resulting in a reduction in their demand for the primary product. To compensate for this negative impact, the gatekeeper firm G has to reduce its product price m_S in the primary market.

In summary, the impact of self-preferencing on firms' pricing strategies in the primary and adjacent markets can be outlined as follows:

Property 1. *In the benchmark, self-preferencing:*

- *increases the 1P service price p_G;*
- *decreases the 3P service price p_C; and*
- *decreases the primary product price m_S.*

We then examine the gatekeeper firm's profit to shed light on the incentives for self-preferencing. We find that competing firms always suffer from self-preferencing. However, for the gatekeeper firm, engaging in self-preferencing may be either profitable or not, as summarized in Property 2.

Property 2. *In the benchmark, the practice of self-preferencing always reduces the profit of competing firms. However, self-preferencing can either increase or decrease firm G's profits. Specifically, self-preferencing decreases firm G's profit when $\beta_s < -2t$ and increases it otherwise.*

The underlying mechanisms are as follows. In the adjacent market, self-preferencing makes the 1P service more attractive. As a result, competing firms experience a lower market share and are forced to reduce their service prices. Both effects diminish the competing firms' profits. However, for the gatekeeper firm, the opposite occurs. Self-preferencing allows the gatekeeper to charge a higher price, capture a larger market share, and thus achieve a greater profit in the ancillary service market.

In the primary market, a larger proportion of sellers are forced to use the 1P service at a higher price following self-preferencing. This reduces the profitability of sellers entering the market and discourages their participation. The resulting decrease in demand for the primary product, in turn, lowers the gatekeeper firm's profits in the primary market. When the value of 3P services is significantly higher than that of the 1P service, most sellers are 3P sellers who incur a surplus loss after self-preferencing. As a result, the gatekeeper firm must substantially reduce the primary product price to offset sellers' loss. In this context, the negative impact becomes dominant, making self-preferencing unprofitable for the gatekeeper. Interestingly, our results also suggest that the gatekeeper firm may be motivated to engage in self-preferencing even when its ancillary service is inferior to that of its rivals (i.e., $\beta_s < 0$). This contrasts with the conventional Chicago School critique, which argues that dominant firms rarely have the incentive to foreclose more efficient rivals.

Turning to the demand for market participation, we find that self-preferencing can lead to either higher or lower participation, depending on both buyers and sellers' preference over ancillary services. Precisely, the results can be summarized in the following corollary:

Property 3. *In the benchmark, self-preferencing can either increase or decrease the demand for market participation. Specifically,*

- *if 1P sellers derive much lower surplus than 3P sellers, i.e., $\beta_s < -2t$, then self-preferencing decreases sellers' demand for market participation; Otherwise, it is the opposite;*
- *If buyers prefer 1P sellers, i.e., $\beta_b > 0$, then self-preferencing decreases buyers' demand for market participation; Otherwise, it is the opposite.*

When the gatekeeper firm practices self-preferencing, several conflicting effects emerge on seller participation. The underlying mechanisms can be illustrated by revisiting sellers' entry decisions:

$$\begin{aligned} E[U_s] &= \sum_{k=1}^{N}\left(\int_0^{\bar{\theta}}(v_G^s - p_G - tx)dx + \int_{\bar{\theta}}^{1}(v_G^s - \beta_s - p_k - tx)dx\right)\frac{1}{N} - m_S, \\ &= -m_S + \int_0^{q_G}\underbrace{(\frac{v^s}{2} - t + \frac{\beta_s}{6} - tx)}_{\text{sellers using 1P service}}dx + \int_0^{1-q_G}\underbrace{(\frac{v^s}{2} - t - \frac{\beta_s}{6} - tx)}_{\text{sellers using 3P service}}dx. \end{aligned} \tag{10}$$

As illustrated in Equation 10, self-preferencing reduces the surplus of 3P sellers while increasing the surplus of 1P sellers. Additionally, as demonstrated in Property 1, self-preferencing motivates the gatekeeper to lower the primary product price, thereby enhancing the surplus of sellers. When 3P services become more attractive, a larger proportion of sellers choose 3P services. This increased share of 3P sellers amplifies the negative effects of self-preferencing, ultimately leading to a overall reduction in seller participation when β_s falls below a certain threshold.

As for buyers, their market participation can be either encouraged or discouraged after self-preferencing. As illustrated in the previous analysis, self-preferencing encourages more sellers to choose the 1P service. When buyers prefer the 1P service over 3P services for fulfilling interactions, self-preferencing drives more sellers to switch to the ancillary service that buyers favor. In this case, buyers are better off and more inclined to enter the market. Conversely, when buyers strongly prefer 3P sellers over 1P sellers, self-preferencing steers more sellers toward the ancillary services that buyers dislike. As a result, buyers are discouraged from entering the market following self-preferencing.

Note that within the model setup, the total surplus of sellers and buyers can be expressed as:

$$\begin{aligned} Surplus_S^* &= \int_0^{n_S} E[U_s]dO + \int_{n_S}^1 OdO = \int_0^{n_S} n_S dO + \int_{n_S}^1 OdO = \frac{1+n_S^2}{2}, \\ Surplus_B^* &= \frac{1+n_B^2}{2}, \end{aligned}$$

where O is the outside option. Since the user surplus in both groups is increasing in their participation, we could view market participation as a measure of user surplus in each group. Keeping this in mind, our results suggest that self-preferencing doesn't always diminish user surplus at equilibrium. Instead, it has the potential to benefit both buyers and sellers if specific conditions are satisfied. The finding is in surprising contrast to a common belief that self-preferencing is detrimental to consumers or sellers. In the benchmark, we demonstrate that, in the short run, both buyers and sellers may achieve a higher surplus after self-preferencing.

The more interesting results emerge when combining Property 2 with Property 3. We find that the gatekeeper firm's incentive for self-preferencing is always aligned with the sellers' interests. As summarized in Property 4, sellers always benefit from self-preferencing when such practice is profitable for the gatekeeper. This occurs because, after self-preferencing, a larger proportion of sellers choose the 1P service. In other words, for each additional seller attracted to the market, the gatekeeper firm, on average, earns higher profits following self-preferencing. This enhances the dominant firm's incentive to attract more sellers, making it willing to lower the primary product price in exchange for a larger market size. Consequently, sellers benefit from this mechanism.

Property 4. *In the benchmark, when the gatekeeper firm finds self-preferencing profitable, the surplus of sellers always increases following self-preferencing. However, the impact of self-preferencing on buyers' surplus can be either positive or negative. Specifically,*

- *if $\beta_b > 0$, self-preferencing increases buyers' participation and their surplus;*
- *if $\beta_b < 0$, self-preferencing reduces buyers' participation and their surplus.*

As for buyers, harmful impacts may arise even when the gatekeeper firm is motivated by self-preferencing. The findings highlight the potential negative effects of self-preferencing on welfare and clarify the conditions under which it may occur. More importantly, they emphasize the critical role of buyers' preferences in determining the impact of self-preferencing on social welfare.

Finally, it is crucial to complement the previous analysis with a long-run assessment. So far, we have taken the number of firms in the adjacent market as exogenously given and focused on short-run impacts. Given that self-preferencing regulations may backfire in the short run, it is natural to ask whether such practices can cause harm over time and whether regulatory intervention is necessary.

The answer can be illustrated by a simple scenario in which $\beta_b = 0$. This corresponds to the market where buyers perceive all sellers and ancillary services as identical. As shown in the previous analysis, the practice of self-preferencing reduces the profits of competing firms. In the long run, these profit reductions discourage the entry of competing firms, enabling the gatekeeper to gradually monopolize the ancillary service market. We are interested in whether such monopolization in the ancillary market may diminish social welfare.

To investigate, we compare the market equilibrium before and after the gatekeeper successfully monopolizes the adjacent market. In the scenario where the ancillary service is monopolized by the gatekeeper firm G, it is optimal for firm G to continue increasing its price until the seller whose preferred service would be 3P offerings derives zero surplus. In other words, the primary product and ancillary service can now be viewed as a bundle with the equilibrium price of $p_G + m_S = v_G^s - t$, and the resulting profit of the gatekeeper firm now equals $\pi_G^* = t(v_G^s - t)/2$. The corresponding equilibrium demands for market participation are:

$$n_S^* = \frac{t}{2} \text{ and } n_B^* = v_G^b.$$

Comparing this monopoly case with the benchmark, we find that sellers earn a lower surplus and are discouraged from entering the market, provided that the sellers' valuation for market participation (v_G^s) is not too low. Buyers, in the absence of network effects, experience no change in surplus in this example. However, when positive network effects are accounted for—as discussed in the following section—the reduction in seller participation negatively affects buyers as well, ultimately diminishing buyer surplus.[13] The results highlight that, while self-preferencing in a competitive ancillary service market may not generate welfare loss in the short run, its evolution into a monopoly market in the long run can pose significant risks to social welfare.

The benchmark model developed in this section highlights the complex tradeoffs faced by regulators

[13]With positive network effects, self-preferencing diminishes the surplus of both buyer and sellers as long as v_G^b and v_G^s are not too low.

in addressing cross-market self-preferencing. In the following section, we first consider some extensions (with additional ones presented in the Appendix) and then examine a case of how such tradeoffs play out in practice, using the FCA's intervention in the Google adtech case as a case study.

3 Extensions

In this section, we explore two extensions. First, we examine the role of network effects in determining self-preferencing impact. Next, we study how the gatekeeper firm's access to different pricing instruments affects self-preferencing welfare implications.

Network Effect

As highlighted in the existing literature, a key characteristic of two-sided markets is the presence of network effects: a user's surplus from joining the market typically increases in the participation of the other group. Incorporating these positive cross-group network effects, we reach qualitatively similar conclusions to those in the benchmark. When self-preferencing is profitable for the gatekeeper, sellers benefit, while buyers may be either better off or worse off. However, after the introduction of network effects, there are changes in the conditions under which the gatekeeper firm finds it profitable to engage in self-preferencing, as well as the circumstances where the harmful impact on buyers may emerge.

When there are network effects, each seller anticipates a higher profit/surplus as more buyers join the market. These network effects are captured by the linear expression $e_s n_B$, where $e_s > 0$ measures the strength of network effects. Combining the network effects with sellers' surplus in the benchmark, the total surplus of seller j if using ancillary service from firm $i \in \{G, 1, 2, ..., N\}$ is now equal to:

$$U_s(\theta_j, i) = e_s n_B - m_S + v_i^s - p_i - t|\theta_j - l_i|.$$

Similarly, on the buyer side, network effects are represented by $e_b n_S$, where $e_b > 0$ measures the magnitude of network effects derived from each seller. To guarantee profit concavity, we assume network effects satisfy $0 < e_b e_s < 1$. Accordingly, a buyer's total expected utility from joining the market is given by $U_b = e_b n_S + v_i^b$ if her transaction is fulfilled by the ancillary service from firm $i \in \{G, 1, 2, ..., N\}$.

Following the same steps as detailed in the Appendix, we find that network effects can either increase or decrease the gatekeeper's incentive for self-preferencing, depending on buyers' preference over ancillary services.

Property 5. *In a two-sided market with positive network effects, network effects enhance the gatekeeper's incentive for self-preferencing when buyers prefer the 1P service over the 3P services, and reduce its incentive otherwise. Specifically, the practice of self-preferencing is profitable for firm G when* $\beta_s > -2t - e_s\beta_b$*, and non-profitable otherwise.*

Network effects make the participation of buyers and sellers positively correlated. As a consequence, the gatekeeper firm G's strategy becomes jointly determined by both sides of the market. If buyers exhibit a growing preference for 1P sellers over 3P sellers, they benefit from self-preferencing as it encourages more interactions to be fulfilled through their favored ancillary service. This positive impact on buyers, in turn, spreads to the seller side through network effects, generating an additional incentive for firm G to practice self-preferencing. Conversely, if buyers prefer 3P sellers over 1P sellers, self-preferencing leads more sellers toward the ancillary services that buyers dislike, thereby discouraging buyer participation. This negative impact on buyers diminishes seller entry, discouraging the gatekeeper firm's incentive for self-preferencing.

In summary, network effects can either strengthen or diminish the gatekeeper firm's incentive for self-preferencing, depending on the vertical differentiation between ancillary services for buyers. This result is intriguing because, on the one hand, it suggests that improving buyers' preference for the gatekeeper's ancillary service—either through quality enhancements or marketing efforts—will increase the gatekeeper's incentive for self-preferencing. On the other hand, this suggests that the expectation of extracting future profits through self-preferencing may give the established and dominant company a strong incentive to offer and invest in high-quality ancillary services. In contrast, newer or smaller companies in the primary product market, or competing firms in adjacent markets, may lack such incentives. This difference in investment motivation can, in turn, make it even harder for smaller companies to compete with larger firms in both the primary product and ancillary service markets.

This finding aligns with recent observations on Temu, a Boston-based, Chinese-owned shopping platform. Since its launch in 2022, Temu has invested heavily in expanding its market share, frequently holding the top spot for mobile downloads among both Apple and Android users over the past two years.[14] Despite its popularity, Temu has faced significant criticism regarding its ancillary services. As pointed out by Time[15]: "Temu has had trouble delivering within the promised time window." In 2023, the company had a C rating from the Better Business Bureau (BBB) and an average customer rating of 1.4 out of 5 stars. Unlike Amazon, an established dominant marketplace, Temu does not have its own

[14] See https://www.cbc.ca/news/business/key-things-to-know-about-temu-online-shopping-1.6850217

[15] See https://time.com/6243738/temu-app-complaints/

logistics network and relies heavily on external shipping providers like UPS, USPS, and FedEx. Temu's rapid market expansion has significantly increased the demand for shipping, with carriers reportedly handling around 900,000 packages per day in the U.S.[16] However, external logistics providers lack sufficient investment incentive to keep up with this growth. As a result, consumers suffer from the disconnect between Temu's aggressive market expansion and the insufficient investment by external shipping companies to handle the increased demand.

In addition to the gatekeeper's self-preferencing incentive, we also analyze welfare implications and derive Property 6.

Property 6. *In a two-sided market with positive network effects,*

- *self-preferencing increases seller participation when* $\beta_s > -2t - e_s\beta_b$ *and decreases otherwise;*
- *self-preferencing increases buyer participation when* $\beta_b > -\frac{e_b(2t+\beta_s)}{2-e_b e_s}$ *and decreases otherwise.*

Combining the results in Property 5 and Property 6, we find qualitatively similar conclusions to the benchmark: the gatekeeper's motivation for self-preferencing aligns with the sellers' interests. However, the gatekeeper's motivation for self-preferencing can conflict with buyers' interests, even when buyers benefit from positive network effects.

Property 7. *In a two-sided market with positive network effects, if firm G finds self-preferencing profitable, then sellers' surplus increases following self-preferencing. However, its impact on buyers' surplus can be either positive or negative. Specifically, self-preferencing increases buyers' participation and their surplus when* $\beta_b > -\frac{e_b(2t+\beta_s)}{2-e_b e_s}$ *and decreases otherwise.*

Interestingly, Property 5 and 6 also suggest that the gatekeeper's incentive for self-preferencing may better align with social welfare, potentially generating superior market outcomes compared to a system in which sellers determine which ancillary service should be favored. Indeed, when network effects are strong, the gatekeeper internalizes much of the externalities that buyers and sellers impose on each other. To illustrate this, consider the hypothetical extreme in which the network effect parameters e_b and e_s approach their maximum value of 1. In this case, the gatekeeper's motivation for self-preferencing (in Property 5) perfectly overlaps with the surplus of both buyers and sellers (in Property 6), and thus becomes fully aligned with social welfare. Strong network effects, in this sense, naturally regulate the gatekeeper's behavior by incentivizing it to account for the welfare of both sides of the market.

[16]See https://www.supplychaindive.com/news/temu-shein-shipping-delivery-industry-impact/725215/.

This stands in contrast to an alternative model in which sellers—who select and pay for ancillary services—are given direct control over whether the 1P or 3P service is promoted or supported. In such a setting, sellers are likely to favor the service that offers them higher quality. However, because they internalize only part of the value that buyers derive from these services, they may prioritize their own profits over overall service quality for both parties. As a result, they might promote services that are more lucrative for them but less desirable to buyers. When cross-group network effects are strong, this misalignment can significantly reduce buyer participation, thereby amplifying welfare losses. Therefore, in digital markets characterized by strong cross-group network effects, centralized self-preferencing by a gatekeeper may lead to more efficient outcomes than a fragmented, seller-driven selection process.

Price Instruments

Next, we explore the possibility that the gatekeeper firm can charge both buyers and sellers and examine how the gatekeeper's access to pricing tools affects the impact of self-preferencing. This scenario is analogous to the display advertising market, where most advertisers use Google's advertising technology with a positive charge. In this context, a buyer's utility when her interaction is fulfilled by ancillary service i is denoted as $U_b = v_i^b - m_B$, where m_B is the gatekeeper's charge from buyers. Accordingly, firm G's profit becomes $\pi_G = m_B n_B + m_S n_S + p_G Q_G$. All other setups remain the same as in the benchmark.

As illustrated in the Appendix, when the gatekeeper charges both buyers and sellers, the impact of self-preferencing on user participation and thus surplus remains the same as in the benchmark. As for the gatekeeper's motivation for self-preferencing, the conclusion is also qualitatively similar as shown in the following Property.

Property 8. *If firm G charges both buyers and sellers in the primary market, there exists a cutoff $\bar{\beta}_s$ such that the practice of self-preferencing is profitable for firm G when $\beta_s > \bar{\beta}_s$, and non-profitable otherwise. Precisely, $\bar{\beta}_s \leq -2t$ when $\beta_b \geq 0$ and $\bar{\beta}_s > -2t$ otherwise.*

When the gatekeeper charges both buyers and sellers, its strategy regarding self-preferencing is jointly determined by both buyers' and sellers' preferences over ancillary services. When buyers prefer 1P sellers over 3P sellers, firm G is more likely to engage in self-preferencing than in the benchmark, i.e., $\bar{\beta}_s < \beta_s$. However, when buyers prefer 3P sellers over 1P sellers, the motivation for self-preferencing diminishes, i.e., $\bar{\beta}_s < \beta_s$. In this context, it is still possible for both buyers and sellers to benefit from self-preferencing under specific conditions. The findings can be summarized as shown in Property 9.

Property 9. *In a two-sided market where firm G charges both buyers and sellers for the primary product, if firm G finds self-preferencing profitable, then both buyers' and sellers' surplus can either increase or decrease following self-preferencing. Precisely,*

- *if firm G finds self-preferencing profitable and buyers prefer 3P sellers and 1P sellers ($\beta_b < 0$), then self-preferencing always increases sellers' surplus while decreasing buyers' surplus;*
- *if firm G finds self-preferencing profitable and buyers prefer 1P sellers and 3P sellers ($\beta_b > 0$), then self-preferencing*
  - *increases both sellers' and buyers' surplus when $\beta_s > -2t$, and*
  - *increases buyers' surplus while decreasing sellers' surplus when $\beta_s < -2t$.*

Comparing Property 9 with Property 4, we find that the conclusions in this section largely align with those in the benchmark. The only exception arises when $\beta_b > 0$ and $\beta_s < -2t$: under these conditions, self-preferencing increases buyer surplus but reduces seller surplus when the gatekeeper charges both sides. In contrast, in the benchmark, self-preferencing increases surplus for both buyers and sellers. This discrepancy stems from the gatekeeper's stronger incentive to self-preference when buyers contribute to its profits and exhibit a strong preference for the 1P ancillary service. In such cases, the gatekeeper is motivated to engage in self-preferencing even at the expense of seller welfare.

4 Empirical Illustration: The FCA-Google AdTech Remedy

We now revisit the FCA case and the evidence in Figures 1 to make two contributions. First, we provide a concise but informative ex post evaluation of the FCA intervention. Given the central role of the adtech market in financing digital platforms and sustaining key sectors—particularly news and media—it is crucial to develop an evidence-based understanding of how regulation affects market outcomes. This is especially timely as other antitrust authorities, notably in the European Union and the United States, are considering how to address the alleged abuses of Google in this sector. Second, we show how our model can be used to empirically analyze alternative counterfactual scenarios, with a focus on evaluating different regulatory remedies against self-preferencing.

The empirical analysis draws on data on advertising performance for a selection of popular websites across the European Economic Area (EEA) and other OECD countries. We focus on two key outcomes:

publishers' advertising revenue and the number of unique advertisers placing ads on each domain. These metrics correspond to the FCA's theory of harm, which argued that Google's auction practices misled publishers about bid quality and, in turn, discouraged advertiser participation.

Further details on the institutional background of the adtech industry, as well as the FCA case, are provided in the Appendix. In brief, in June 2021 the FCA fined Google for favoring its own programmatic advertising services. The investigation focused on the two mandatory and complementary adtech layers used by publishers—ad servers and SSPs—and concluded that Google engaged in self-preferencing across these two layers, harming competing services. To restore competition in France, Google agreed to a series of commitments. We focus on one key measure: granting rival SSPs the same access to ad auction data as its own services. This commitment was critical because SSPs rely on auction data to optimize bidding strategies. Google's dominance in the ad auction market was largely sustained by its superior access to such data, which provided a significant informational advantage. By contrast, competing SSPs often lacked the information needed to understand lost auctions and improve performance. To address these concerns, Google committed to share auction data with rival SSPs starting in June 2022.

If the FCA commitment had effectively restored competition, we would expect both metrics to increase. However, as shown in Table 2, the simple comparison of averages pre- and post-intervention indicate a decline in France that is sharper than in other, comparable countries, suggesting that the remedy may have produced unintended consequences.

Table 2: Advertiser Count and Revenue Following FCA Regulation

		Top 50 Popular Domains		Top 50 Popular News		Top 10 Popular News	
		France	Others	France	Others	France	Others
Advertiser Count	Before	626.18	413.75	448.23	206.26	861.76	259.76
	After	311.19	321.42	197.28	148.46	342.00	207.47
Revenue	Before	270.14	454.81	99.45	92.19	340.19	247.94
	After	115.89	406.04	55.13	79.37	117.19	206.09

Notes: The first two columns consist of the top 50 web domains in EEA and OECD country. The third and fourth columns consist of top 50 popular domains in news and media of 10 European countries, and the last two columns restricted the new and media domains to top 10. The time frame is between January 2022 and January 2023 and the sampling details are provided in the Appendix.

The descriptive evidence in Table 2 is supported by more sophisticated empirical strategies. In particular, Figure 1, introduced earlier, applies a synthetic control approach (Abadie et al., 2010). The dashed line marks June 30, 2022, the deadline for implementing Google's data-sharing commitment.

Prior to the intervention, France and the synthetic control exhibit similar trends; however, they diverge sharply afterward. Unexpectedly relative to the intended consequences of the antitrust intervention, both publisher revenue and advertiser participation decline in France following the data-sharing requirement. As shown in the Appendix, the findings are robust to alternative specifications, including a two-way fixed effects model and a different sample of popular news and media websites in the EEA.

These results underscore that the effects of regulating self-preferencing are more nuanced than often assumed, and poorly designed remedies may even backfire, reducing overall market surplus. This naturally raises the question: how should antitrust authorities intervene, if at all? For the adtech market in Europe and the US, valuable insights linking our model's implications to real-world practice can be drawn from the published documents of relevant investigations. In parallel to the FCA, both the U.S. Department of Justice (DoJ) and the EC have investigated Google's self-preferencing in the adtech industry.[17] In the US, Google has already been found guilty and is required to comply with remedies that prohibit it from entering into or maintaining exclusive contracts related to the distribution of Google Search, Chrome, Google Assistant, and the Gemini app. The EC case remains ongoing, with no remedies determined or implemented at the time of our research. Notably, unlike the FCA, the EC and DoJ extended their investigations to the advertiser side.

The key findings concerning the advertiser side in the adtech industry can be summarized as follows: (i) the majority of advertisers rely on Google to purchase ad slots from publishers,[18] and Google's dominance fosters strong network effects, further increasing the scale and diversity of its advertiser user base; (2) Google's adtech stands apart from competitors due to its data-targeting advantages, powered by a vast range of user data collected from its leading products, such as Chrome, Gmail, and Google Search, as well as data from its ad networks on the publisher side; (3) Google's ad buying tools typically restrict the performance of non-Google adtech used by publishers so that most advertisers tend to derive

[17] See https://www.justice.gov/opa/pr/justice-department-sues-google-monopolizing-digital-advertising-technologies and https://ec.europa.eu/commission/presscorner/detail/en/ip_23_3207 for details.

[18] The market share of Google Ads has exceeded 90% in both the US and Europe. Such a high market concentration has been achieved through Google's varied strategies in past years. One key factor influencing advertisers' choice of ad buying tools is the access to valuable advertising inventory. Google has effectively bundled several of its critical advertising inventory, such as Google Search, YouTube, Gmail, and the Google Play Store, with its technology. For example, advertisers seeking to purchase advertising on YouTube are typically required to use Google's ad buying tools, leaving them with no alternative but to adopt Google's technology.

a low value and face a diminished success rate of completing transactions through non-Google SSPs.[19]

As pointed out by the DoJ regarding the latter issue, advertisers using Google Ads are prohibited from submitting bids to competing SSPs based on the same bid modeling and targeting data used for Google's own SSP. In July 2017, Google launched "Project Poirot," which artificially and systematically reduced the bids sent to rival SSPs. During this period, the default setting of Google's ad buying tool, Display & Video 360 (DV360), was updated to automatically opt into Project Poirot. Due to the default effect, over 99% of advertising campaigns were subjected to this practice. Consequently, the performance of interactions between advertisers' ad buying tools and non-Google SSPs is likely to be poor, with a low probability of resulting in successful transactions.

Translating the market features described above to our model, buyers in the current display advertising market are likely to derive a minimal value from interacting with sellers through 3P services (non-Google SSPs). In such a market scenario, i.e., $\beta_b > 0$, the data patterns observed in France align closely with our theoretical predictions. Alleviating self-preferencing on the publisher side improves the performance of competing firms' ancillary services (SSPs) and enhances competition. However, this positive effect on social welfare can be undermined if the gatekeeper firm's adtech also dominates on the advertiser side, allowing it to significantly restrict the performance of rival SSPs from both sides of the market. Therefore, regulating such phenomena on only one side of the market without simultaneously enhancing the value of competing ancillary services on the other side may be ineffective in improving social welfare. We then use our model jointly with the display advertising data to evaluate counterfactual policy interventions in this market, including the structural divestitures that are under discussion as remedies for the EC case.

Counterfactual Policy Comparison

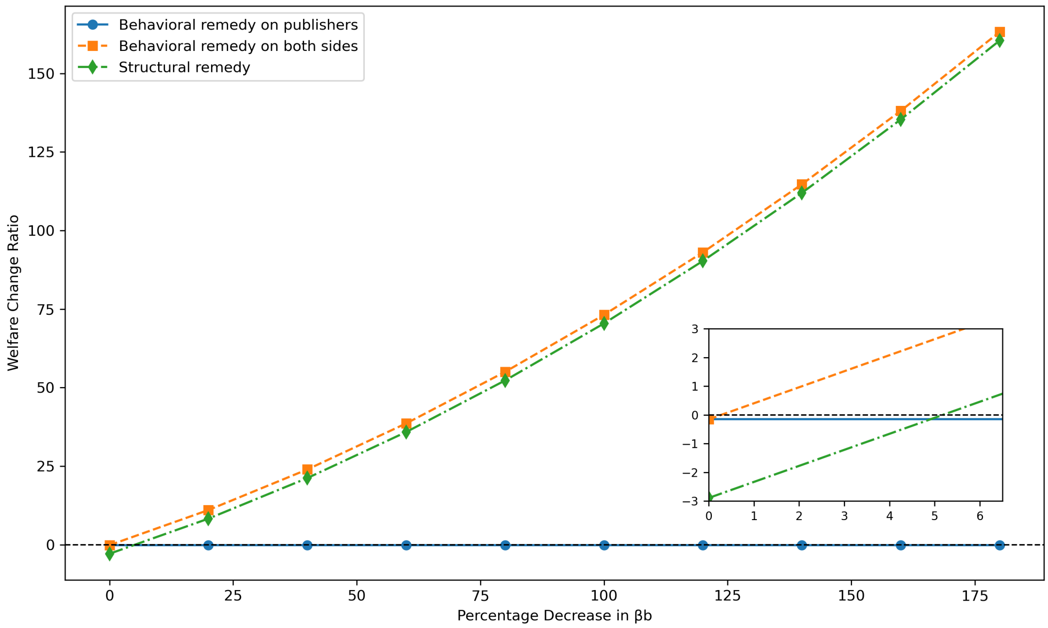
To compare the efficiency of different regulatory approaches, we estimate the changes in social welfare resulting from various interventions. Specifically, we first estimate the welfare loss among the top popular French websites in news and media after the FCA regulation. We then conduct two counterfactual exercises to evaluate alternative remedies. The first exercise considers an enhanced

[19] We also notice that Google has significant flexibility in adjusting its pricing strategy in the display advertising market. The pricing of adtech is often viewed as a "black box" for publishers and advertisers. For example, in the SSP layer, the charge for a transaction is on an individual basis for each impression and is highly dynamic. As long as the "average" revenue share remains at the contractually set rate, Google is permitted to set the adtech charge at an extremely high or extreme low (even negative) value on a case-by-case basis. This dynamic pricing mechanism and its associated rules allow Google to adjust its adtech charge for each transaction, granting it considerable freedom in the pricing strategy. In this market context, Google can adjust its pricing strategy within a wide range without publishers or advertisers noticing.

behavioral intervention that aims to increase the value of 3P services for both publishers and advertisers. The second exercise examines whether, and under what conditions, a structural remedy could yield more effective welfare improvements than behavioral remedies. This structural approach is motivated by Google's recent proposal to divest AdX as part of its settlement negotiations with the EC. Compared to behavioral remedies, divestment is expected to be more effective in removing the gatekeeper's incentive for self-preferencing. However, given the complexity of digital markets and the coordinating role of Google, its ultimate effect on social welfare remains uncertain.

We begin the analysis by estimating model parameters using the Method of Simulated Moments (MSM). Precisely, we match model-generated moments of advertiser count and publisher revenue with their empirical counterparts from the display advertising market, focusing on popular news and media websites. Details of this estimation are provided in the Appendix.

Figure 4: Social Welfare Impact of Different Regulations



Note: The blue line shows the change in total welfare in France following the FCA regulation; the orange line reflects an alternative remedy improving 3P services for both publishers and advertisers; and the green line represents a divestment scenario. The horizontal axis indicates the extent of reduced vertical differentiation for advertisers, with 100% meaning no perceived vertical differentiation.

Based on the estimation results, we next simulate the impact of the FCA remedy, which targeted self-preferencing solely on the publisher side. According to our analysis, advertisers in France strongly preferred interacting with publishers who use Google's adtech. On average, advertisers gained 10 times more value from publishers using the 1P service than from those using 3P alternatives. On the publisher side, the value of the 1P service is also higher than that of 3P services before the FCA regulation. After the FCA regulation, around 75% of this quality gap disappeared for publishers. However, as the theoretical model predicts, addressing self-preferencing only on the publisher side reduces surplus for both advertisers and publishers. Consistent with this prediction, we observe that, rather than improving, total social surplus—defined as the combined surplus of advertisers and publishers—declined by 0.15% as indicated by the blue line in Figure 4.

Such a reduction in social welfare can be addressed with an alternative remedy design. Specifically, we investigate the potential impact of an enhanced remedy: instead of addressing self-preferencing only on the publisher side, this alternative policy also targets Google's current strategy that discourages advertisers from interacting with publishers using non-Google adtech. In Figure 4, the orange line shows the percentage change in total welfare in France when, in addition to the same magnitude of rival adtech improvement for publishers as under the FCA regulation, a behavioral remedy also reduces the relative advantage of 1P over 3P services for advertisers. The horizontal axis represents the extent to which vertical differentiation between 1P and 3P services is reduced. When this ratio reaches 100 percent, all vertical differentiation disappears, and advertisers perceive no difference between interacting with publishers through 1P or 3P services.

Our results show that while the FCA remedy alone leads to a decline in total welfare, its effectiveness improves substantially when it also enhances the value of 3P services for advertisers. Specifically, we find that greater reductions in vertical differentiation lead to increasingly larger gains in total welfare. When the vertical differentiation between 1P and 3P services for advertisers is reduced by more than 0.30%, the overall welfare effect of the regulation becomes positive.

Next, we evaluate the potential effects of a structural remedy. During negotiations between the EC and Google, the possibility of divesting AdX was discussed. To disentangle the underlying forces, we decompose the overall changes in market outcomes after a potential divestment as follows:

$$\begin{aligned}\Delta EQ &= EQ'(\beta_s', \beta_b') - EQ(\beta_s, \beta_b), \\ &= EQ'(\beta_s', \beta_b') - EQ(\beta_s', \beta_b') + EQ(\beta_s', \beta_b') - EQ(\beta_s, \beta_b), \\ &\approx \underbrace{EQ'(\beta_s', \beta_b') - EQ(\beta_s', \beta_b')}_{\text{induced by market structure adjustment}} + \underbrace{\frac{\partial EQ(\beta_s, \beta_b)}{\partial \beta_b}(\beta_b' - \beta_b)}_{\text{induced by } \beta_b \text{ adjustment}} + \underbrace{\frac{\partial EQ(\beta_s, \beta_b)}{\partial \beta_s}(\beta_s' - \beta_s)}_{\text{induced by } \beta_s \text{ adjustment}},\end{aligned} \tag{11}$$

where ΔEQ represents the overall changes in market outcome, EQ is the equilibrium strategy before divestment, EQ' is the equilibrium strategy after divestment, β_s and β_b measures the relative value of

3P service for sellers and buyers before the intervention, and β_s' and β_b' measures the relative value of 3P service for sellers and buyers after the intervention.

As shown in Equation 11, the overall market change following divestment can be categorized into three effects. First, given the ancillary service values, the equilibrium strategy changes due to modifications in market structures. Second, given the market structure and equilibrium strategy, buyers' value of 3P services may improve as self-preferencing incentives are completely removed after the divestment. Third, similar to the buyer side, sellers' valuation of 3P services may also improve following the divestment. The third effect, driven by an improvement in sellers' valuation of 3P services, is similar to the FCA intervention and has been well-studied in previous analyses. Therefore, the focus of our analysis is the first two new effects and their overall impact on social welfare.

To investigate these effects, we analyze a scenario where the ownership of the 1P service transfers from Google, the gatekeeper firm, to an independent company. After divestment, the gatekeeper derives profit solely from the primary market and adjusts its strategy accordingly. By solving the profit maximization problem, we can easily derive the new market equilibrium following divestment as shown the Appendix. Based on this equilibrium, we then simulate market outcomes and compute changes in total welfare. In Figure 4, the green line shows the total welfare change ratio in France after the divestment, with the horizontal axis representing the reduction in vertical differentiation between 1P and 3P services for advertisers.

Interestingly, we find that divestment is generally less effective than a behavioral remedy when both interventions enhance the value of 3P services for both sides of the market by the same amount. In other words, the first effect in Equation 11 is always negative. Specifically, if divestment improves the value of 3P services only for publishers without affecting advertisers, the expected reduction in total welfare is approximately 2.89%. This indicates that divestment is even less effective than the FCA remedy currently in place. This outcome occurs because divestment lowers the profit that each user generates for the gatekeeper firm. Consequently, the dominant firm's incentive to expand market size diminishes, leading to a lower aggregate demand for market participation. At the same time, competing firms tend to experience reduced profits after divestment. Over the long run, this negative impact may accelerate their exit, ultimately decreasing overall competition in the ancillary service market.

Nevertheless, our results suggest the second effect in Equation 11 is positive, meaning that the effectiveness of divestment increases when the 3P service value improves for advertisers. The finding underscores that divestment can outperform behavioral remedies in enhancing social welfare, provided it more effectively removes Google's incentive to favor its own services on both sides of the market. In other words, if divestment results in a substantially greater improvement in advertisers' value of

3P services compared to behavioral interventions, its impact on welfare becomes more favorable. Specifically, when the vertical differentiation between the 1P and 3P services is reduced by the same magnitude as under the FCA remedy for publishers and by more than 5.49% for advertisers, the total social welfare increases as a result of divestment.

In summary, compared to the FCA regulation whose impacts are largely captured by the third component of Equation 11, divestment generates two additional and conflicting effects on social welfare. On one hand, divestment reduces the gatekeeper's incentive to maintain a large market and may discourage entry, thereby shrinking overall participation. On the other hand, it can more effectively eliminate the gatekeeper's motivation for self-preferencing, potentially leading to a stronger improvement in advertisers' valuation of 3P services. As a result, there is no definitive conclusion about which regulatory approach is superior.

Our findings offer a clear policy insight: structural remedies like divestment can be highly effective, but only if they sufficiently improve the quality of competitive ancillary services across the entire market chain for both sides of the market. When applied to just one side of the market, such remedies risk repeating the limitations of behavioral interventions, as seen in the French market following the FCA's action. Effective regulation must account for the bilateral nature of digital platforms and ensure that interventions restore functionality for both buyers and sellers. Otherwise, policies aimed at promoting competition may unintentionally fragment the market and reduce overall efficiency.

5 Conclusions

The FCA's 2021 case against Google highlights the complex challenges regulators face in addressing self-preferencing in digital platform markets. The behavioral remedy imposed—requiring Google to share auction data with rival SSPs—was intended to level the playing field but led to unintended consequences: both publisher revenue and advertiser participation declined. This case illustrates how traditional remedies, even when well-intended, can produce adverse effects in complicated digital markets.

To better understand these counterintuitive outcomes, we developed a unified framework capturing core features of cross-market self-preferencing: sellers choose and pay for ancillary services, yet their choices influence outcomes for buyers as well. We show that a dominant gatekeeper can profit from self-preferencing even when its own ancillary service is not superior in quality. More importantly, the welfare implications can be either positive or negative, depending on buyer and seller preferences and the platform's pricing instruments.

These theoretical insights reveal two critical lessons. First, remedies that target only one side of the market—without accounting for cross-side dynamics—can misalign incentives and reduce welfare. By addressing self-preferencing solely on the publisher side, the FCA intervention pushed publishers toward rival technologies that advertisers were less willing to use, diminishing participation on both sides. Second, curbing self-preferencing may also reduce the gatekeeper's incentive to maintain a large, well-functioning ecosystem. This mechanism is not just theoretical: Apple's recent response to an EC fine for restricting communication of alternative payment options in its App Store exemplifies it. Although Apple formally lifted the marketing restriction, it introduced two new fees—a 5% user acquisition fee and a 10% services fee on out-of-store transactions. This illustrates how gatekeepers may re-optimize their pricing strategies post-regulation and diminish market size.

Our paper resonates with ongoing policy debates and yields several implications. First, the EC's draft guidelines on Article 102 of the Treaty on the Functioning of the European Union (TFEU) propose, for the first time, a structured definition of self-preferencing as an exclusionary abuse.[20] Our findings underscore that regulation must account for the two-sided nature of self-preferencing, even when the ancillary service is not a bottleneck input. Second, the recent ruling in the US against Google signals a growing willingness to consider structural remedies. Our model supports this approach, but only in cases where structural changes improve rival quality for both sides of the market. Indeed, through counterfactual simulations, we identify conditions under which alternative behavioral or structural interventions improve welfare, offering actionable thresholds for policy design.

Our study suggests several avenues for future research. One is to extend the framework to multiple forms of self-preferencing, such as Amazon's simultaneous promotion of its own brand and logistics services. Another is to empirically examine how regulation affects multi-homing and longer-term market dynamics beyond short-run surplus effects. Lastly, introducing competition in the primary market may reveal additional forces shaping self-preferencing incentives.

In summary, this paper provides the first integrated theoretical and empirical analysis of cross-market self-preferencing in digital platform ecosystems. As public scrutiny of digital platforms intensifies on both sides of the Atlantic, designing regulatory evidence-based interventions that are both targeted and comprehensive will be essential for improving market outcomes.

[20] See https://eur-lex.europa.eu/eli/treaty/tfeu_2012/oj/eng.

References

Abadie, A., A. Diamond, and J. Hainmueller (2010). Synthetic control methods for comparative case studies: Estimating the effect of california's tobacco control program. *Journal of the American statistical Association 105*(490), 493–505.

Anderson, S. and Ö. Bedre Defolie (2024). Hybrid Platform Model: Monopolistic Competition and a Dominant Firm. *The RAND journal of economics 55*(4), 684–718.

Athey, S. and F. Scott Morton (2021). Platform Annexation.

Bar-Isaac, H. and S. Shelegia (2022). Monetizing Steering.

Belleflamme, P. and M. Peitz (2021). *The Economics of Platforms*. Cambridge University Press.

Bergemann, D. and A. Bonatti (2024). Data, competition, and digital platforms. *American Economic Review 114*(8), 2553–2595.

Biglaiser, G., E. Calvano, and J. Crémer (2019). Incumbency Advantage and Its Value. *Journal of Economics & Management Strategy 28*(1), 41–48.

Bisceglia, M. and J. Tirole (2023). Fair Gatekeeping in Digital Ecosystems.

Chen, N. and H.-T. T. Tsai (2024). Steering via Algorithmic Recommendations. *RAND Journal of Economics*.

Choi, J. P. and D.-S. Jeon (2021). A Leverage Theory of Tying in Two-Sided Markets with Nonnegative Price Constraints. *American Economic Journal: Microeconomics 13*(1), 283–337.

Crawford, G., J. Crémer, D. Dinielli, A. Fletcher, P. Heidhues, M. Luca, T. Salz, M. Schnitzer, F. Scott Morton, K. Seim, and M. Sinkinson (2023). Consumer Protection for Online Markets and Large Digital Platforms. *Yale Journal on Regulation 40*, 875.

Crawford, G. S., J. Crémer, D. Dinielli, A. Fletcher, P. Heidhues, M. Schnitzer, F. Scott Morton, and K. Seim (2023). Equitable Interoperability: The "Super Tool" of Digital Platform Governance. *Yale Journal on Regulation*.

De Corniere, A., K. Jerath, and G. Taylor (2024). Fulfilled By Amazon: Marketplace Tying of Ancillary Services. *mimeo*.

De Corniere, A. and G. Taylor (2014). Integration and Search Engine Bias. *The RAND Journal of Economics 45*(3), 576–597.

De Corniere, A. and G. Taylor (2019). A model of biased intermediation. *The RAND Journal of Economics 50*(4), 854–882.

Decarolis, F., M. Li, and F. Paternollo (2025). Competition and Defaults in Online Search. *American Economic Journal: Microeconomics (forthcoming)*.

Dendorfer, F. (2024). First-party selling and self-preferencing. *International Journal of Industrial Organization 97*, 103098.

Dong, X. and J. Cong (2024). Platform Dominance and Across-Market Bundling. *Available at SSRN 4652442*.

Etro, F. (2023). Hybrid Marketplaces with Free Entry of Sellers. *Review of Industrial Organization 62*(2), 119–148.

Farronato, C., A. Fradkin, and A. MacKay (2023). Self-Preferencing at Amazon: Evidence from Search Rankings. Technical report, National Bureau of Economic Research.

Gambato, J. and M. Risco (2024). Based on the Papers You Liked: Designing a Rating System for Strategic Users. *mimeo*.

Gutiérrez, G. (2022). The Welfare Consequences of Regulating Amazon.

Hagiu, A. and B. Jullien (2011). Why do intermediaries divert search? *The RAND Journal of Economics 42*(2), 337–362.

Hagiu, A., T.-H. Teh, and J. Wright (2022). Should Platforms Be Allowed to Sell on Their Own Marketplaces? *The RAND Journal of Economics 53*(2), 297–327.

Heidhues, P., M. Kösters, and B. Kîoszegi (2024). A Theory of Digital Ecosystems. *ECONtribute Discussion Paper*.

Hunold, M. and J. Muthers (2017). Resale price maintenance and manufacturer competition for retail services. *The RAND Journal of Economics 48*(1), 3–23.

Inderst, R. and M. Ottaviani (2012). Competition through commissions and kickbacks. *American Economic Review 102*(2), 780–809.

Johnen, J. and R. Somogyi (2024). Deceptive Features on Platforms. *The Economic Journal*.

Jullien, B. (2005). Two-Sided Markets and Electronic Intermediaries. *CESifo Economic Studies 51*(2-3), 233–260.

Kang, Z. Y. and E. V. Muir (2022). Contracting and Vertical Control by a Dominant Platform. In *EC*, pp. 694–695.

Kittaka, Y. and S. Sato (2022). Dual-Role Platforms and Self-Preferencing: Sequential Search Approach. *Available at SSRN 3736574*.

Lam, H. T. (2021). Platform Search Design and Market Power. *Job Market Paper, Northwestern University*.

Lee, K. H. and L. Musolff (2021). Entry into Two-Sided Markets Shaped by Platform-Guided Search. *Job Market Paper, Princeton University*.

Li, L., S. Tadelis, and X. Zhou (2020). Buying Reputation as a Signal of Quality: Evidence from an Online Marketplace. *The RAND Journal of Economics 51*(4), 965–988.

Long, F. and Y. Liu (2023). Platform Manipulation in Online Retail Marketplace with Sponsored Advertising. *Marketing Science*.

Motta, M. (2023). Self-Preferencing and Foreclosure in Digital Markets: Theories of Harm for Abuse Cases. *International Journal of Industrial Organization*, 102974.

Ostrovsky, M. (2023). Choice-screen auctions. *American Economic Review 113*(9), 2486–2505.

Padilla, J., J. Perkins, and S. Piccolo (2022). Self-Preferencing in Markets with Vertically Integrated Gatekeeper Platforms. *The Journal of Industrial Economics 70*(2), 371–395.

Rochet, J.-C. and J. Tirole (2004). Two-Sided Markets: An overview. *Institut d'Economie Industrielle working paper*.

Shen, B. and J. Wright (2019). Why (don't) firms free ride on an intermediary's advice? *International Journal of Industrial Organization 64*, 27–54.

Tadelis, S. (2016). Reputation and Feedback Systems in Online Platform Markets. *Annual Review of Economics 8*(1), 321–340.

Teh, T.-H. (2022). Platform Governance. *American Economic Journal: Microeconomics 14*(3), 213–254.

Teh, T.-H. and J. Wright (2022). Intermediation and Steering: Competition in Prices and Commissions. *American Economic Journal: Microeconomics 14*(2), 281–321.

Waldfogel, J. (2024). Amazon Self-Preferencing in the Shadow of the Digital Markets Act. Technical report, National Bureau of Economic Research.

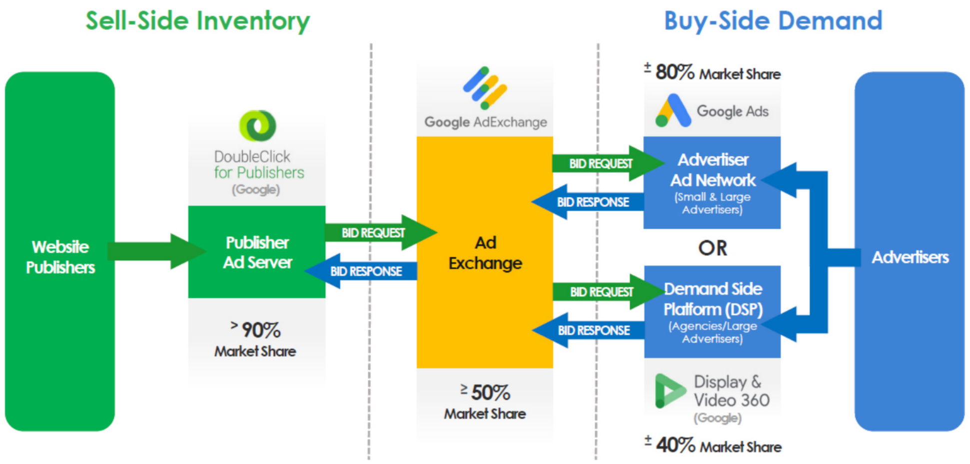
Zennyo, Y. (2022). Platform Encroachment and Own-Content Bias. *The Journal of Industrial Economics 70*(3), 684–710.

A Appendix

A.1 Institutional Background on the Adtech Industry

In the display advertising market, publishers, like websites and apps, constitute the supply (seller) side that offers available ad spaces, and advertisers represent the demand (buyer) side that purchases spaces to catch eyeballs. Both publishers and advertisers rely on an intricate chain of advertising technologies to accomplish interactions with each other.

Figure A.1: DOJ's Diagram of Google's Ad Business



In a simplified adtech stack as shown in Figure A.1, there are three main blocks of adtechs. Precisely, ad servers work as the first technology layer for publishers. The servers assist publishers in managing ad inventory and displaying relevant ads. The second technology layer for publishers encompasses supply-side platforms (SSPs), which actively solicit bids from advertisers and organize auctions for specific impressions. Advertisers, likewise, also need ad-buying tools to optimize bids and participate in auctions organized by SSPs. Large advertisers typically use demand-side platforms (DSPs) that offer sophisticated and customizable ad-purchasing tools. Smaller advertisers, on the other hand, often rely on simpler advertising solutions provided by ad networks.

Each layer in the adtech stack plays an indispensable role and operates in the following sequence: when a user visits a website or app, the publisher's ad server first receives information about available impressions, i.e., ad slots for that particular user. The server then requests bids for these impressions from the connected SSPs. The SSPs transmit these requests to advertisers, who then use ad-buying tools to determine the bid amount on their behalf. The ad-buying tools then send the winning bids back to the SSPs. After receiving bids from multiple ad-buying tools, the SSPs conduct an auction among all the bids, choose the winner, and return the winning bid to the publisher's ad server. Lastly, the publisher's ad server conducts a final auction among the bids received from its SSPs and notifies the selected ad to be displayed.

Among these three components, the publisher ad server and SSP markets have been the focus of an investigation by the FCA. The case is centered exclusively on the adtechs used by publishers, without considering the advertiser side. Compared to other layers of the adtech stack, publisher ad servers tend to exhibit a high degree of "stickiness": publishers rarely switch ad servers due to the substantial costs and risks involved. As the former CEO of DoubleClick pointed out in a Google internal strategy meeting:

> *"My view is nothing really matters but the platform [publisher ad server]. Nothing has such high switching costs… Switching platforms is a nightmare. Takes an act of God to do it."*

In the current display advertising market, Google is active in all layers of adtech stack. The company provides an ad server, "DoubleClick for Publishers (DFP)", and an SSP, "Google AdExchange (AdX)" for publishers. The DFP and AdX both fall under Google's re-branded "Google Ad Manager" services, but they fulfill distinct functions. On the advertiser side, Google offers a DSP, "Display & Video 360 (DV360)", for large advertisers and an ad network, "Google Ads", for small advertisers. More importantly, Google holds dominant positions in multiple adtech layers. In the United States, for instance, Google's DFP controls over 90% of the publisher ad server market. In terms of SSPs, Google manages more than 50% of ad sales. On the advertiser side, Google Ads captures around 80% of demand, while DV360 holds about 40%. Similar trends are observed in Europe.[21]

In June 2021, the FCA concluded its investigation and fined Google €220 million for prioritizing its programmatic advertising services under the Google Ad Manager brand.[22] According to the FCA, Google had been engaging in reciprocal self-preferencing across these two adtech layers: it provided more advantageous terms to its SSP (AdX) compared to competing firms, including allowing AdX to optimize its algorithm using competitors' bids and restricting competitors' data access to auction outcomes. Furthermore, Google's AdX was also found to favor its server (DFP) by making it the only ad server fully interoperable with AdX.

As pointed out by the FCA, Google's practices were identified as having substantial anti-competitive effects within the markets for publisher ad servers and SSPs. These actions reduced

[21] See https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3929310.

[22] See https://www.autoritedelaconcurrence.fr/sites/default/files/attachments/2021-07/21-d-11_ven.pdf.

competition among adtech intermediaries and adversely affected both publishers and advertisers. There are signs that publishers utilizing Google's ad server were not presented with the highest possible bids from competing SSPs. Further evidence, including internal Google documents, also suggests that the company misled publishers about the benefits of its services. Both effects led to revenue loss for publishers.[23] For advertisers, Google's high extraction rates force them to pay inflated prices, leaving them worse off. These market distortions not only harm advertisers and publishers but also undermine the quality of ad tech tools and stifle innovation. Ultimately, this situation negatively impacts consumers. Reduced revenue for publishers limits their ability to offer free online content, potentially leading to the introduction of more paywalls or subscription models, thereby restricting consumers' access to information.

To address the anti-competitive concerns, Google reached an agreement with the FCA to gradually fulfill a series of commitments in France[24], including (i) allowing fair access to information on the auction process for third-party SSPs; (ii) preserving the full contractual freedom of third-party SSPs so that they can negotiate special conditions with publishers and are not blocked from deciding to include or exclude specific buyers; (iii) ensuring that AdX no longer uses the price of its competitors in order to optimize its bids in a way that is not reproducible by third-party SSPs; (iv) offering guarantees of technical stability, both for third-party SSPs and for publishers; and (v) making changes to existing configurations that allow publishers using third-party ad servers to access AdX on-demand in "real-time".

[23] See https://awards.concurrences.com/en/awards/2022/business-articles/the-french-competition-authority-fines-a-big-tech-company-eur220-million-for.

[24] According to the FCA, the commitments are binding for publishers whose registered place of business is in the European Economic Area (EEA), have material activities in the EEA, and use ad servers or SSPs to serve ads to users with an IP address in France. See https://www.autoritedelaconcurrence.fr/sites/default/files/commitments/2021-08/google_committments_english_version_21d11.pdf.

A.2 Additional Analysis on FCA Case

To investigate whether any clear patterns emerged after the FCA regulation, we collected data from various sources for our main analysis. First, we use Similarweb[25], an Israeli firm specializing in web traffic and performance analysis, to identify the top 50 most popular websites across a series of EEA and OECD countries in February 2023. Specifically, our list includes 26 countries: Argentina, Australia, Belgium, Brazil, Canada, Switzerland, Germany, Denmark, Spain, Finland, France, the United Kingdom, Indonesia, India, Italy, Mexico, Malaysia, the Netherlands, Norway, New Zealand, the Philippines, Sweden, Singapore, the United States, Vietnam, and South Africa. Based on this sample list, we then gather advertising performance data from the SEMrush platform.[26] The time frame for our sample is from January 2022 to January 2023.[27] The final sample consists of 23,045 observations.

In the main text, we employ the synthetic control technique proposed by Abadie et al. (2010). Specifically, we construct a synthetic control group composed of EEA and OECD countries that most closely resemble France, the treated group. Our analysis suggests a sharp drop in both publishers' advertising revenue and advertisers' participation in France following Google's data-sharing commitment. To ensure the validity of our findings, we conducted multiple robustness checks. First, we estimate the impact of regulation using an alternative difference-in-differences identification strategy. Specifically, we utilize the following Two-Way-Fixed-Effects model as our baseline specification:

$$Y_{cdt} = \alpha + \beta(Treated_c \times Post_t) + \lambda_c + \gamma_t + \theta_d + \varepsilon_{cdt}, \qquad (12)$$

where Y_{cdt} represents the variable under investigation of domain d in country c during week t. λ_c denotes the country fixed effect, γ_t represents the week fixed effect, θ_d represents the domain fixed effect, and $Treated_c \times Post_t$ is the treatment variable, which is an indicator for the treated group following the implementation of the policy in June 2022. As shown in Table A.1, we find qualitatively similar results to those reported in the main text: a significant decline in both publishers' advertising revenue and advertisers' participation in France following Google's data-sharing commitment.

[25] See https://www.similarweb.com/.

[26] See https://www.semrush.com/.

[27] We exclude websites belonging to the FAANG group (Alphabet, Amazon, Apple, Meta, Microsoft, and Netflix), as they may behave differently from other websites.

Table A.1: FCA Remedy Impact on Popular Websites

	(1) Revenue	(2) Revenue	(3) Revenue	(4) Advertisers	(5) Advertisers	(6) Advertisers
Post 06/2022	-40.847**			-91.299***		
	(15.778)			(7.544)		
France	-176.657***			213.912***		
	(49.737)			(23.781)		
Treated × Post 06/2022	-114.111	-114.111	-114.111**	-223.214***	-223.214***	-223.214***
	(67.344)	(61.623)	(43.019)	(32.200)	(29.520)	(16.940)
Week FE	No	Yes	Yes	No	Yes	Yes
Country FE	No	Yes	Yes	No	Yes	Yes
Domain FE	No	No	Yes	No	No	Yes
R-squared	0.003	0.168	0.601	0.012	0.172	0.732
Observations	23045	23045	23045	23045	23045	23045

Our second set of robustness checks uses an alternative sample consisting of the top 100 most popular news and media websites across selected EEA countries, including Belgium, Germany, Denmark, Spain, Finland, France, Italy, the Netherlands, Norway, and Sweden in September 2023.[28] As shown in Table A.2, the estimates based on this media sample are broadly consistent with those obtained using the top 50 most popular websites in the EEA and OECD countries.

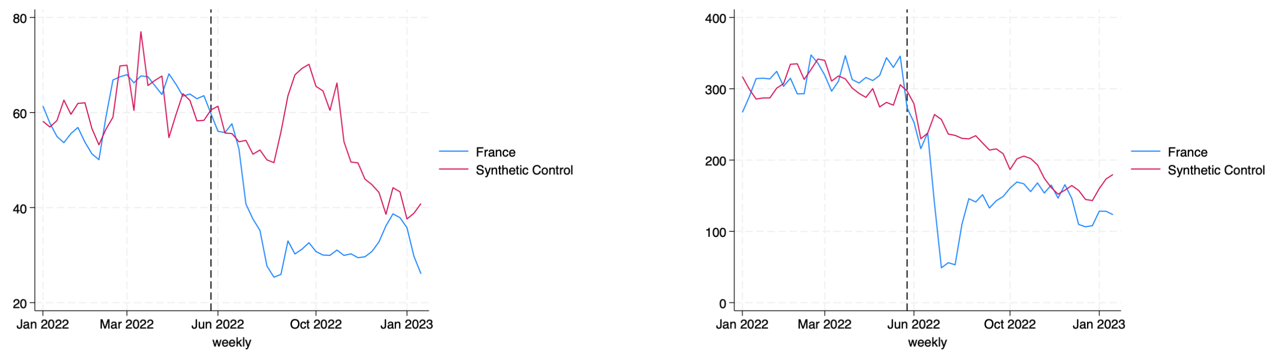
Table A.2: FCA Remedy Impact on News-and-Media Websites

	(1) Revenue	(2) Revenue	(3) Revenue	(4) Advertisers	(5) Advertisers	(6) Advertisers
Post 06/2022	-8.665**			-50.284***		
	(2.870)			(4.589)		
France	-1.545			123.702***		
	(5.540)			(8.857)		
Treated × Post 06/2022	-17.233*	-17.233*	-17.233***	-119.027***	-119.027***	-119.027***
	(7.688)	(7.632)	(4.525)	(12.291)	(11.800)	(7.267)
Week FE	No	Yes	Yes	No	Yes	Yes
Country FE	No	Yes	Yes	No	Yes	Yes
Domain FE	No	No	Yes	No	No	Yes
R-squared	0.001	0.017	0.660	0.014	0.093	0.662
Observations	30212	30212	30212	30212	30212	30212

In Figures A.2a and A.2b, we plot the weekly averages of advertising revenue and advertiser counts for popular news and media domains in both the treated and synthetic control groups, yielding qualitatively similar results.

[28] Following the same procedure as in the previous analysis, we exclude the FAANG group from the sample, resulting in a final dataset of 30,212 observations.

Figure A.2: News and Media Market: Pre- and Post-FCA Intervention



(a) Publisher Revenue ($ Thousands)

(b) Number of Advertisers

A.3 Self-Preferencing by Apple and Amazon

Examining the current digital market, it becomes evident that the self-preferencing phenomenon is increasingly prevalent. In addition to Google's self-preferencing in the advertising market, another notable example is Apple's practice in the mobile device market. In March 2024, the EC fined Apple €1.8 billion for exploiting its dominant position in the App Store to favor its own electronic payment channel. As pointed out by the EC, Apple is the sole provider of the App Store, where app developers and iOS users interact. The company also provides payment technology and channels for app developers to process users' subscriptions. According to the EC's investigation, Apple has imposed strong marketing restrictions that prevented streaming app developers from fully informing iOS users about alternative, lower-cost music subscription channels available outside of Apple.

Specifically, these anti-competitive practices include: (i) prohibiting the communication of subscription prices available outside the app to iOS users within the app, (ii) preventing the disclosure of price differences between in-app subscriptions, sold through Apple's own payment system, and those offered elsewhere, and (iii) forbidding the inclusion of links within the apps that would direct iOS users to the app developer's website, where alternative subscription options could be purchased. Additionally, app developers were prohibited from contacting newly acquired users—such as via email—to inform them about alternative pricing options after they had set up an account.

As a result, the majority of iOS users complete their subscriptions within Apple's ecosystem but end up paying significantly higher prices. This is due to the substantial commission fees Apple imposes on developers, which are ultimately passed on to consumers in the form of higher subscription prices. Consequently, iOS users are believed to be severely harmed by Apple's self-preferencing practices.

Likewise, in December 2022, Amazon was accused by the EC of discouraging sellers from using rival logistics services to fulfill Amazon orders. When sellers fulfill orders on Amazon, they can either manage storage and delivery independently or outsource these tasks to an operator. Amazon itself offers corresponding services to sellers through its Fulfillment by Amazon (FBA) program. According to the EC's investigation, Amazon has been promoting its own logistics service by providing it with unique advantages on the platform, including (i) non-application of performance metrics to third-party sellers; (ii) obtaining the Prime Badge; (iii) higher probability of being awarded the Buy Box; (iv) participation in special events and offers; and (v) eligibility for "Free Shipping via Amazon."

All these benefits play critical roles in facilitating selling on Amazon. For instance, one significant advantage for FBA sellers is their higher chance of winning the Buy Box. Unlike others, sellers who win the Buy Box can be immediately added to buyers' shopping carts through the "Add to Basket" button or be purchased directly through the "Buy Now" button. Due to this convenience, most Amazon sales occur through Buy Box recommendations. Taking Germany and France as examples, the EC highlighted that between 70% and 90% of total Amazon sales in these countries were finished through the Buy Box between 2017 and 2019. In its communications with sellers, Amazon also stated that "90% or more of sales come from the Buy Box."[29]

Another significant advantage of FBA sellers is their increased likelihood of obtaining Amazon Prime labels. Over the past years, there has been steady growth in the number of Prime users on Amazon. These Prime users typically spend more on Amazon than regular users and strongly prefer Prime offers. According to the EC, between 70% and 90% of total spending by Prime users in the German, French, and Spanish Amazon marketplaces was associated with Prime offers. As a consequence, qualifying for Prime labels becomes crucial for sellers to attract demand.

While FBA sellers automatically qualify for the Prime label, sellers who fulfill their own orders (FBM) must meet the stringent requirements of Amazon's Seller Fulfilled Prime (SFP) program. This includes entering into an agreement with an Amazon-designated carrier and complying with shipping terms negotiated by Amazon. These logistical and contractual hurdles create a significant barrier for FBM sellers, effectively nudging them toward using Amazon's fulfillment services.

Given these disparities in treatment, the majority of sellers had little practical choice but to adopt FBA. This widespread adoption not only reinforced Amazon's dominant position in the e-commerce marketplace but also allowed it to expand rapidly into the shipping and logistics industry. By integrating more sellers into its fulfillment network, Amazon gained comparative advantages over traditional logistics providers, thereby solidifying its market power across multiple layers of the supply chain.

[29] See https://ec.europa.eu/competition/antitrust/cases1/202310/AT_40703_8990760_1533_5.pdf

A.4 Markets with Network Effects

Based on the model setup in Section 3, we solve for the subgame perfect equilibrium. To avoid trivial market equilibria, we make the following assumptions in this section:

Assumption 2. *In a two-sided market with network effects, we assume:*

- ***[Profit Concavity]*** *the network effects satisfy $e_s > 0$, $e_b > 0$, and $e_b e_s < 1$ to guarantee profit concavity;*
- ***[Positive Demand]*** *the ancillary service values satisfy $|\beta_s| < 3t$ so that both 1P service and 3P service derive a positive demand at equilibrium; and*
- ***[Competitive Market and Market Participation]*** *the surplus v^s and v_G^b satisfy the conditions such that there exists competition between the 1P service and 3P service, and user entry does not hit corner solution.*

The introduction of network effects does not affect the transaction stage in the adjacent market, thus the demand and firms' pricing strategy over ancillary services stay the same as in the benchmark. However, buyers and sellers' market participation change. Precisely, a seller's expected surplus from joining the market, denoted as $E[U_s]$, equals:

$$E[U_s] \quad = \quad e_s n_B - m_S + \sum_{k=1}^{N} \left(\int_0^{\bar{\theta}(k)} (v_G^s - p_G - tx)dx + \int_{\bar{\theta}(k)}^{1} (v_G^s - \beta_s - p_k - t(1-x))dx \right) \frac{1}{N}.$$

As for buyers, their expected utility depends on the distribution of sellers among ancillary services and can be written as:

$$E[U_b] = e_b n_S + \sum_{k=1}^{N} \left(\int_0^{\bar{\theta}(k)} v_G^b dx + \int_{\bar{\theta}(k)}^{1} (v_G^b - \beta_b) \right) \frac{1}{N}.$$

Users in both groups will join the market if they expect to derive a higher surplus than their outside options. Hence, the demands for market participation in both groups are given by $n_S = E[U_s]$ and $n_B = E[U_b]$.

Given the ancillary service prices (expression 1-2) and demands (expression 3-4) at equilibrium, the explicit demands for market participation can be expressed as:

$$n_B = \frac{6\beta_b(\beta_s - 3t) + 36tv_G^b + e_b\beta_s^2 - 9te_b(4m_S + 5t - 2v_s)}{36t(1 - e_be_s)},$$
$$n_S = \frac{\beta_s^2 + 6e_s(\beta_b\beta_s - 3t\beta_b + 6tv_G^b) - 9t(4m_S + 5t - 2v_s)}{36t(1 - e_be_s)}.$$

Maximizing firm G's profit by solving the first-order condition, we derive the profit-maximizing primary product price as:

$$m_S^* = \frac{6e_s\beta_b\beta_s - \beta_s^2 - 18e_s\beta_bt - 12\beta_st - 63t^2 + 36e_stv_G^b + 18tv^s}{72t}.$$

Accordingly, the equilibrium demands for market participation are given by:

$$n_B^* = \frac{2(2 - e_be_s)\beta_b(\beta_s - 3t) + 24tv_G^b + e_b(\beta_s^2 + 4\beta_st - 9t^2 - 12te_sv_G^b + 6tv_s)}{24t(1 - e_be_s)},$$
$$n_S^* = \frac{2e_s\beta_b\beta_s + \beta_s^2 - 6e_s\beta_bt + 4\beta_st - 9t^2 + 12e_stv_G^b + 6tv^s}{24t(1 - e_be_s)},$$

and the resulting demands for ancillary services are $Q_G^* = (\frac{1}{2} + \frac{\beta_s}{6t})n_S^*$ and $Q_C^* = (\frac{1}{2} - \frac{\beta_s}{6t})n_S^*$.

We lastly calculate the equilibrium profits of firms and derive:

$$\pi_G^* = \frac{(2e_s\beta_b\beta_s + \beta_s^2 - 6e_s\beta_bt + 4\beta_st - 9t^2 + 12e_stv_G^b + 6tv^s)^2}{576t^2(1 - e_be_s)},$$
$$\pi_C^* = \frac{(3t - \beta_s)^2(2e_s\beta_b\beta_s + \beta_s^2 - 6e_s\beta_bt + 4\beta_st - 9t^2 + 12e_stv_G^b + 6tv^s)}{432Nt^2(1 - e_be_s)} - L.$$

To investigate the impact of self-preferencing on market competition, we calculate the derivative of n_S with respect to β_s and obtain:

$$\frac{dn_S}{d\beta_s} = \frac{e_s\beta_b + \beta_s + 2t}{12t(1 - e_be_s)}.$$

Under Assumption 2, the value of $dn_S/d\beta_s$ is increasing in β_b. Specifically, $dn_S/d\beta_s$ is negative if $\beta_s < -2t - e_s\beta_b$, and it's positive if $\beta_s > -2t - e_s\beta_b$.

As for buyer participation, its derivative with respect to β_s equals:

$$\frac{dn_B}{d\beta_s} = \frac{2\beta_b - e_b e_s \beta_b + e_b \beta_s + 2e_b t}{12t(1-e_b e_s)}.$$

Under Assumption 2, it is easy to show that the value of $dn_B/d\beta_s$ is increasing in β_b. Specifically, $dn_B/d\beta_s$ is positive when $\beta_b > -\frac{e_b(2t+\beta_s)}{2-e_b e_s}$ and negative otherwise.

We next check how firm G's profit changes when β_s increases. Calculating the derivation of firm G's profit with respect to β_s, we derive:

$$\frac{d\pi_G}{d\beta_s} = \frac{(e_s\beta_b + \beta_s + 2t)(2e_s\beta_b\beta_s + \beta_s^2 - 6e_s\beta_b t + 4\beta_s t - 9t^2 + 12e_s t v_G^b + 6tv^s)}{144t^2(1-e_b e_s)}.$$

Since the denominator is always positive, the sign of $d\pi_G/d\beta_s$ is determined by the numerator $(e_s\beta_b + \beta_s + 2t)(2e_s\beta_b\beta_s + \beta_s^2 - 6e_s\beta_b t + 4\beta_s t - 9t^2 + 12e_s t v_G^b + 6tv^s)$. Under Assumption 2, the equation $2e_s\beta_b\beta_s + \beta_s^2 - 6e_s\beta_b t + 4\beta_s t - 9t^2 + 12e_s t v_G^b + 6tv^s$ is always positive. Therefore, $d\pi_G/d\beta_s$ is positive if $\beta_s > -2t - e_s\beta_b$ and negative otherwise. In other words, $d\pi_G/d\beta_s$ increases and is more likely to be positive when $\beta_b > 0$ and there is stronger network effect e_s.

A.5 Market with Fees on Both Sides

Based on the model setup in Section 3, we solve for the subgame perfect equilibrium in this section. The introduction of buyer fee does not affect the transaction stage in the adjacent market, thus the demand and firms' pricing strategy over ancillary services stay the same as in the benchmark. However, buyers and sellers' market participation change.

When buyers also need to pay the gatekeeper m_B to join the market, the demands for market participation are affected and can be written as:

$$\begin{aligned} n_S &= -m_S + \sum_{k=1}^{N} \left(\int_0^{\bar{\theta}(k)} (v_G^s - p_G - tx)dx + \int_{\bar{\theta}(k)}^1 (v_G^s - \beta_s - p_k - t(1-x))dx \right) \frac{1}{N}, \\ n_B &= -m_B + \sum_{k=1}^{N} \left(q_G(k)v_G^b + (1-q_G(k))(v_G^b - \beta_b) \right) \frac{1}{N}. \end{aligned}$$

Correspondingly, the explicit demands for market participation can be simplified as:

$$\begin{aligned} n_B &= v_G^b - m_B + \frac{\beta_b(\beta_s - 3t)}{6t}, \\ n_S &= \frac{\beta_s^2 - 9t(4m_S + 5t - 2v_s)}{36t}. \end{aligned}$$

Given the demands, we next examine firm G's optimal pricing strategy. For firm G, it charges both buyers and sellers and its profit (π_G) is expressed as:

$$\pi_G = m_B n_B + m_S n_S + \sum_{k=1}^{N} p_G \frac{(\beta_s - p_G + p_k + t)n_S}{2Nt}.$$

Maximizing its profit, the gatekeeper's equilibrium price in the primary market can be derived as follows.

$$\begin{aligned} m_B^* &= \frac{\beta_b\beta_s - 3\beta_b t + 6tv_G^b}{12t}, \\ m_S^* &= \frac{18tv^s - \beta_s^2 - 12\beta_s t - 63t^2}{72t}. \end{aligned}$$

To investigate the welfare implication of self-preferencing, we calculate the equilibrium demands for market participation and derive:

$$n_B^* = \frac{\beta_b\beta_s - 3\beta_b t + 6tv_G^b}{12t}, \tag{13}$$

$$n_S^* = \frac{\beta_s^2 + 4\beta_s t - 9t^2 + 6tv^s}{24t}. \tag{14}$$

Analyzing how n_B^* and n_S^* evolve when firm G practices self-preferencing, we find qualitatively similar findings to Property 3.

$$\frac{\partial n_B^*}{\partial \beta_s} = \frac{\beta_b}{12t},$$

$$\frac{\partial n_S^*}{\partial \beta_s} = \frac{\beta_s + 2t}{12t}.$$

As for the impact of self-preferencing on firm G's profit, the corresponding derivative can be written as:

$$\frac{\partial \pi_G^*}{\partial \beta_s} = \underbrace{\frac{2\beta_b(\beta_b\beta_s - 3\beta_b t + 6tv_G^b)}{144t^2}}_{\text{First Component}} + \underbrace{\frac{(\beta_s + 2t)(\beta_s^2 + 4\beta_s t - 9t^2 + 6tv^s)}{144t^2}}_{\text{Second Component}}.$$

Following the same steps as in the benchmark, we can easily show that the second component derive similar conclusion as the benchmark. Precisely, the value of the second component is positive when $\beta_s > -2t$ and is positive otherwise. As for the first component, the value of $(\beta_b\beta_s - 3\beta_b t + 6tv_G^b)$ is always positive as long as there are positive number of buyers entering the market. Thus, if $\beta_b > 0$, the first component is always positive. Accordingly, seller preference cutoff $\bar{\beta}_s$ above which the gatekeeper firm chooses to practice self-preferencing must decrease and be lower than $-2t$. In contrast, if $\beta_b < 0$, the first component is always negative. Accordingly, the cutoff above which the gatekeeper firm chooses to practice self-preferencing must increase and be above than $-2t$.

A.6 MSM Estimation

To provide counterfactual exercises regarding alternative regulatory interventions, we estimate key model parameters using the Method of Simulated Moments (MSM). The estimation is conducted using data from the top 100 most popular news and media websites in France, with a focus on two primary outcomes: the count of advertisers posting ads on each website, and the advertising revenue earned by each publisher. These outcomes are observed both before and after the FCA regulation, allowing us to capture shifts in market structure and participant behavior due to regulatory changes.

As the traffic to news websites varies and is relatively concentrated, we introduce heterogeneity across websites to generate realistic simulated data. Specifically, we assume that each publisher's value-relevant parameter for adtech, v^s, follows a Pareto distribution characterized by parameters μ_{vs} and σ_{vs}. Similarly, each advertiser's parameter regarding their standalone value from Google's adtech, v_G^b, is drawn from a Pareto distribution governed by μ_{vGb} and σ_{vGb}. For both distributions, we use μ to denote the scale and σ to denote the shape. These distributions reflect the cross-sectional variation observed in the market and enable the model to produce diverse outcomes for advertisers and publishers across websites. The transportation cost parameter t, representing horizontal differentiation, is fixed at 100 throughout the estimation procedure.

The parameter vector we aim to estimate includes eight parameters. Among them, the distributional parameters $(\mu_{vs}, \sigma_{vs}, \mu_{vGb}, \sigma_{vGb})$ determine the spread and central tendency of advertiser and publisher heterogeneity. The structural parameters include β_s^{pre} and β_s^{post}, which capture the vertical quality gap between the 1P service and competing 3P alternatives for publishers before and after the regulation. We also estimate β_b, representing advertisers' relative value of the 1P service over rivals, and a scale factor k that converts normalized user shares in the model into actual advertiser counts observed in the data.

The estimation strategy relies on matching eight empirical moments: the mean and variance of advertiser count and publisher revenue before and after the FCA regulation. As Google charges fees from both publishers and advertisers, our estimation relies on the model setup in Section 3. Specifically, the model-generated advertiser count and the advertising revenue of publishers, denoted as R, equal:

$$n_B = k \cdot \frac{\beta_b \beta_s - 3\beta_b t + 6tv_G^b}{12t}, \quad R = \frac{5\beta_s^2 - 9t^2 + 18tv_s}{36t}.$$

These equations are evaluated both before and after the policy intervention, using the corresponding values of β_s. For each parameter guess, we simulate the model 1,000 times. In each simulation, we draw 100 pairs of random values (v^s and v_G^b) from the Pareto distribution for 100 websites, compute advertiser participation and publisher revenue based on the model's equilibrium equations. We then calculate the mean and variance of advertiser count and publisher revenue across the 100 websites. Averaging across the 1,000 simulations yields a vector of simulated moments m_{sim}, which we compare to the empirical moment vector m_{emp} derived from French data. Specifically, the objective function Obj is defined as a quadratic form:

$$Obj = (m_{sim} - m_{emp})' W (m_{sim} - m_{emp}),$$

where W is a diagonal weighting matrix constructed as the inverse square of each empirical moment. This weighting matrix ensures that all moment discrepancies are scaled proportionally to their empirical magnitudes.

The estimation is carried out in two steps. In the first step, we use a diagonal weighting matrix and impose constraints to ensure economically meaningful outcomes. Specifically, we require that a positive number of publishers remain after a counterfactual divestment regulation and that advertisers' standalone value for third-party ancillary services is positive. The constrained optimization is performed using Sequential Least Squares Programming (SLSQP). After obtaining initial parameter estimates from the first step, we proceed to the second step by updating the weighting matrix. This is done by simulating the model using the step-one parameter estimates, computing the covariance matrix of the simulated moments, and taking its inverse to form a new weighting matrix. We then re-run the optimization using the updated weights.

To ensure robustness and avoid local minima, we explore 100 random initializations for the parameter vector and select the parameter set that minimizes the objective function as the optimal output. Our final parameter estimates yield an objective value lower than 5.2×10^{-5} and the estimated parameters are as follows:

$$[\beta_s^{pre}, \beta_s^{post}, \beta_b, k, \mu_{vs}, \sigma_{vs}, \mu_{vGb}, \sigma_{vGb}] = [1.09,\ 0.28,\ 2819.18,\ 1.00,\ 5167.27,\ 602.31,\ 3069.58,\ 1000.00].$$

Based on the estimation, we then use the calibrated model to simulate counterfactual policy scenarios and compute the resulting changes in total welfare. Precisely, we consider three main scenarios: (i) the actual behavioral remedy implemented by the FCA, (ii) an enhanced behavioral remedy that improves 3P service value for both sides of the market, and (iii) a structural remedy involving divestment of Google's ancillary service (AdX). In each case, we simulate the market using the estimated parameters and compute the ratio of total surplus change after the policy intervention. Precisely, our welfare metric W focuses on the surplus sum of buyers and sellers:

$$w = Surplus_B^* + Surplus_S^* = \frac{1 + (n_B^*)^2}{2} + \frac{1 + (n_S^*)^2}{2},$$

where n_B^* and n_S^* follows the same format as Equation 13 and Equation 14 in the first two scenarios. In the third scenario, the profit of the dominant firm changes and the equilibrium participation becomes:

$$\begin{aligned} n_B^* &= \frac{\beta_b \beta_s - 3\beta_b t + 6tv_G^b}{12t}, \\ n_S^* &= \frac{\beta_s^2 - 45t^2 + 18tv_s}{72t}. \end{aligned}$$

Let w_{pre} and w_{post} denote the total surplus before and after a policy intervention. The welfare change ratio in Figure 4 is computed as:

$$\Delta W = \frac{w_{\text{post}} - w_{\text{pre}}}{w_{\text{pre}}} \times 100.$$

In all three scenarios, the vertical differentiation between the 1P and 3P services changes from $\beta_s^{pre} = 1.09$ to $\beta_s^{post} = 0.28$ after the regulation.Since the latter two scenarios involve a reduction in vertical differentiation between the 1P and 3P services for advertisers, we analyze different cases in which this differentiation is diminished by varying degrees.

B Online Appendix

B.1 Proofs

Recall that our benchmark focuses on the meaningful market equilibrium under Assumption 1. Precisely, the cutoffs in Assumption 1 can be expressed as:

$$\tilde{v}_G^s = \frac{6\beta_s t + 45t^2 - \beta_s^2}{36t}$$
$$\underline{v}_G^b = \frac{3\beta_b t - \beta_b \beta_s}{6t}$$
$$\bar{v}_G^b = \frac{6t + 3\beta_b t - \beta_b \beta_s}{6t}$$
$$\underline{v}_G^s = \frac{2\beta_s t + 9t^2 - \beta_s^2}{12t}$$
$$\bar{v}_G^s = \frac{12t + 2\beta_s t + 9t^2 - \beta_s^2}{12t}$$

Proof of Property 1 According to Equations (1-2), it is evident that an increase in β_s increases p_G while decreasing p_C. To examine the impact of β_s on the primary product price m_S, we calculate the derivative and obtain:

$$\frac{dm_S}{d\beta_s} = -\frac{\beta_s + 6t}{36t}.$$

Recall that $|\beta_s| < 3t$ under Assumption 1. Thus, the derivative $dm_S/d\beta_s$ is always negative and an increase in β_s always diminishes the primary product price m_S.

Proof of Property 2 We first check how the monopoly firm's profit changes when β_s increases. Calculating the derivation of the firm G's profit with respect to β_s, we derive:

$$\frac{d\pi_G}{d\beta_s} = \frac{(\beta_s + 2t)(\beta_s^2 + 4\beta_s t - 9t^2 + 6tv_s)}{144t^2}.$$

Since the denominator is always positive, the sign of $d\pi_G/d\beta_s$ is determined by the numerator $(\beta_s + 2t)(\beta_s^2 + 4\beta_s t - 9t^2 + 6tv_s)$. Under Assumption 1, the equation $\beta_s^2 + 4\beta_s t - 9t^2 + 6tv_s$ is always positive. Therefore, $d\pi_G/d\beta_s$ is positive if $\beta_s > -2t$ and negative otherwise.

As for the profit of fringe firms, its derivative equals

$$\frac{d\pi_C}{d\beta_s} = \frac{(\beta_s - 3t)(2\beta_s^2 + 3\beta_s t + 3t(-5t + 2v_s))}{216t^2}.$$

Since $|\beta_s| < 3t$ under Assumption 1, equation $(\beta_s - 3t)$ is always negative. Hence, the sign of $d\pi_C/d\beta_s$ is determined by the convex function $H_C = 2\beta_s^2 + 3\beta_s t + 3t(-5t + 2v_s)$ in β_s. We calculate the function's minimum value at $\beta_s = -3t/4$ and derive positive value under Assumption 1. Consequently, the profit of competing firms always diminishes following self-preferencing.

Proof of Property 3 Calculating the derivative of n_S with respect to β_s, we obtain:

$$\frac{dn_S}{d\beta_s} = \frac{\beta_s + 2t}{12t}.$$

As the denominator is always positive, the sign of the derivative is determined by its numerator. Correspondingly, $dn_S/d\beta_s$ is negative if $\beta_s < -2t$, and it's positive otherwise.

As for buyer participation, its derivative with respect to β_s equals:

$$\frac{dn_B}{d\beta_s} = \frac{\beta_b}{6t}.$$

Therefore, the sign of $dn_B/d\beta_s$ is positive when $\beta_b > 0$, and is the opposite otherwise.

B.2 Horizontal Differentiation

In the main text, we assume that the horizontal differentiation between the 1P and 3P services is fixed and unaffected by firms' entry into the adjacent market. In this section, we relax this assumption and explore whether the main conclusions still hold.

To incorporate the impact of firms' entry on the horizontal differentiation between ancillary services, we denote the length of the Hotelling line as $b(N)$, a function of the number of competing firms in the adjacent market. All other setups remain the same as the benchmark. Within this model setup, we then solve for the subgame perfect equilibrium.

If firm G and firm $k \in \{1,2,...,N\}$ are in a seller's consideration set, the seller is indifferent between the two firms when his location $\bar{\theta}(k)$ satisfies $U_S(\bar{\theta}(k),A) = U_S(\bar{\theta}(k),k)$. Solving this equation, we derive the indifferent seller's location as follows:

$$\bar{\theta}(k) = \frac{\beta_s + p_k - p_G + bt}{2t}.$$

Correspondingly, the demands for the two ancillary services can be expressed as:

$$\begin{aligned} Q_G &= \sum_{k=1}^{N} \bar{\theta}(k)\frac{n_S}{N} = \sum_{k=1}^{N} \frac{(\beta_s + p_k - p_G + bt)}{2t}\frac{n_S}{N}, \\ Q_k &= \left(1 - \bar{\theta}(k)\right)\frac{n_S}{N} = (b - \frac{\beta_s + p_k - p_G + bt}{2t})\frac{n_S}{N}. \end{aligned}$$

Given the prices, buyers and sellers make entry decisions and their demand for market participation can be solved as:

$$\begin{aligned} n_S &= -m_S + \sum_{k=1}^{N}\left(\int_0^{\bar{\theta}(k)} (v_G^s - p_G - tx)dx + \int_{\bar{\theta}(k)}^{b} (v_G^s - \beta_s - p_k - t(1-x))dx\right)\frac{1}{bN}, \\ n_B &= \sum_{k=1}^{N}\left(\int_0^{\bar{\theta}(k)} v_G^b dx + \int_{\bar{\theta}(k)}^{b} (v_G^b - \beta_b)dx\right)\frac{1}{bN}. \end{aligned}$$

Each firm maximizes its profit simultaneously and the equilibrium prices are given by:

$$p_G = bt + \frac{\beta_s}{3},$$
$$p_C = bt - \frac{\beta_s}{3},$$

and the resulting ancillary service demands are:

$$Q_G = (\frac{b}{2} + \frac{\beta_s}{6t})n_S,$$
$$Q_C = (\frac{b}{2} - \frac{\beta_s}{6t})\frac{n_S}{N}.$$

Lastly, we proceed to analyze firm G's pricing strategy over the primary product. Plugging in the equilibrium demands and prices, the explicit demands for market participation can be expressed as:

$$n_B = \frac{\beta_b(\beta_s - 3bt) + 6btv_G^b}{6bt},$$
$$n_S = \frac{\beta_s^2 - 36btm_S - 45b^2t^2 + 18btv^s}{36bt}.$$

Maximizing firm G's profit by solving the first-order condition, we derive the profit-maximizing primary product price as:

$$m_S^* = \frac{-\beta_s^2 - 12\beta_s bt - 63b^2t^2 + 18btv^s}{72bt}.$$

Given the equilibrium pricing strategies, the demands for market participation are given by:

$$n_B^* = \frac{\beta_b\beta_s + 6tbv_G^b - 3\beta_b bt}{6bt},$$
$$n_S^* = \frac{\beta_s^2 + 4\beta_s bt - 9b^2t^2 + 6btv^s}{24bt},$$

and the resulting equilibrium profits of firms are:

$$\pi_G^* = \frac{(\beta_s^2 + 4\beta_s bt - 9b^2t^2 + 6btv^s)^2}{576bt^2},$$
$$\pi_C^* = \frac{(3bt - \beta_s)^2(\beta_s^2 + 4\beta_s bt - 9b^2t^2 + 6btv^s)}{432bNt^2} - L.$$

Based on the market equilibrium, we first investigate firm G's motivation for self-preferencing. Precisely, we find that the gatekeeper firm G derives a higher profit following self-preferencing if $\beta_s > -2bt$. Furthermore, analyzing market participation, we derive results qualitatively similar to the benchmark: sellers benefit from self-preferencing as long as it is profitable for firm G, i.e. when $\beta_s > -2bt$. However, buyers may be harmed by self-preferencing when they dislike the 1P service, i.e., $\beta_b < 0$, and benefit from it otherwise.

Note that we now allow b to be endogenously determined by firm entry N so the horizontal differentiation is also affected accordingly. However, since the cutoffs for both firm G and sellers to benefit from self-preferencing are equal, any change in b simply shifts the two cutoffs simultaneously without affecting their relationship. Therefore, allowing horizontal differentiation to vary with the number of competing firms in the ancillary service market does not alter the paper's main conclusion.

B.3 Consideration Set

In the main text, we assume that each seller considers two ancillary services: one is always the 1P service, and the other is a randomly selected 3P service. Thus there is no direct competition among 3P services. In this section, we relax this assumption and analyze the case where services in the consideration set are randomly chosen. In this context, fringe firms not only compete with the gatekeeper firm but also with each other in the adjacent market.

There are two types of indifferent sellers. If the gatekeeper firm G and a competitive fringe firm $k \in \{1, 2, ..., N\}$ are in a seller's consideration set, the indifferent seller's location $\bar{\theta}(k)$ is the same as in the benchmark. If there are two competitive fringe firms $k, j \in \{1, 2, ..., N\}$ in a seller's consideration set, the seller is indifferent between the two firms when he is located at:

$$\bar{\theta}^c(k, j) = \frac{p_k - p_j + t}{2t}.$$

Precisely, sellers will choose firm k's ancillary service if $\theta > \bar{\theta}^c(k, j)$ and firm j's ancillary service otherwise. Given that all firms, including the gatekeeper firm, all have an equal chance to appear in the consideration set, the demands for the 1P and 3P services can be expressed as:

$$\begin{aligned} Q_G &= \sum_{k=1}^{N} \frac{2n_s\bar{\theta}(k)}{N(N+1)}, \\ Q_k &= \frac{2n_s(1-\bar{\theta}(k))}{N(N+1)} + \sum_{j\neq k\in\{1,2,\ldots,N\}} \frac{2n_s(1-\bar{\theta}^c(k,j))}{N(N+1)} \end{aligned}$$

Given the product and service prices, buyers and sellers make entry decisions and their demand for market participation can be solved as:

$$\begin{aligned} n_S &= -m_S + \sum_{k=1}^{N}\left(\int_0^{\bar{\theta}(k)} (v_G^s - p_G - tx)dx + \int_{\bar{\theta}(k)}^1 (v_G^s - \beta_s - p_k - t(1-x))dx\right)\frac{2}{N(N+1)} + \\ &\quad \sum_{k\neq j\in\{1,2,\ldots,N\}}\left(\int_0^{\bar{\theta}^c(k,j)} (v_G^s - \beta_s - p_j - t(1-x))dx + \int_{\bar{\theta}^c(k,j)}^1 (v_G^s - \beta_s - p_k - t(1-x))dx\right)\frac{1}{(N+1)N}, \\ n_B &= \sum_{k=1}^{N}\left(\int_0^{\bar{\theta}(k)} v_G^b dx + \int_{\bar{\theta}(k)}^1 (v_G^b - \beta_b)dx\right)\frac{2}{N(N+1)} + \frac{N(N-1)}{(N+1)N}(v_G^b - \beta_b). \end{aligned}$$

Each firm maximizes its profit and the ancillary service prices at the symmetric equilibrium are given by:

$$\begin{aligned} p_G &= \frac{\beta_s N + t + 2Nt}{1+2N}, \\ p_C &= \frac{-\beta_s + t + 2Nt}{1+2N}. \end{aligned}$$

We then proceed to analyze firm G's pricing strategy over the primary product. Plugging in the equilibrium demands and prices, the explicit demands for market participation can be expressed as:

$$\begin{aligned} n_B &= \frac{\beta_b N(\beta_s - (1+2N)t) + (1+3N+2N^2)tv_G^b}{(1+N)(1+2N)t}, \\ n_S &= \frac{2\beta_s^2N^2 + 2\beta_s(1+3N-4N^3)t - (1+N)(1+2N)^2t(4m_S+5t-2v^s)}{4(1+N)(1+2N)^2t}. \end{aligned}$$

Maximizing firm G's profit by solving the first-order condition, we derive the profit-maximizing primary product price as:

$$m_S^* = \frac{(1+2N)^2 t\,(2(1+N)v^s - (9+5N)t) - 2\beta_s^2 N^2 - 2\beta_s(-1+N+8N^2+4N^3)t}{8(1+N)(1+2N)^2 t}.$$

Given the equilibrium pricing strategies, the demands for market participation are given by:

$$\begin{aligned} n_B^* &= \frac{\beta_b N(\beta_s - (1+2N)t) + (1+3N+2N^2)t v_G^b}{(1+N)(1+2N)t}, \\ n_S^* &= \frac{6\beta_s^2 N^2 + 2\beta_s(1+7N+8N^2-4N^3)t - (1+2N)^2 t(t+5Nt-2(1+N)v^s)}{8(1+N)(1+2N)^2 t}, \end{aligned}$$

and the resulting equilibrium profits of the gatekeeper firm is:

$$\pi_G^* = \frac{\left(6\beta_s^2 N^2 + 2\beta_s(1+7N+8N^2-4N^3)t - (1+2N)^2 t(t+5Nt-2(1+N)v^s)\right)^2}{64(1+N)^2(1+2N)^4 t^2}.$$

Under the condition that there are positive market participation, the gatekeeper firm is motivated to practice self-preferencing when $\beta_s > -(1+7N+8N^2-4N^3)t/6N^2$. As for the welfare implication, we derive qualitatively similar results to the benchmark: sellers benefit from self-preferencing as long as it is profitable for firm G, i.e. when $\beta_s > \beta_s > -(1+7N+8N^2-4N^3)t/6N^2$. However, buyers may be harmed following self-preferencing when they dislike the 1P service, i.e., $\beta_b < 0$, and benefit from it otherwise.

B.4 Outside Option

In the main text, we assume that both buyers' and sellers' outside options follow a uniform distribution on the interval $[0,1]$. In this section, we relax this assumption and let F_b and F_s denote the cumulative distribution functions of buyers' and sellers' outside options, respectively. Under this setup, the demands for market competition are given by $n_S = F_s(E[U_s])$ and $n_B = F_b(E[U_b])$.

The transaction stage in the ancillary service market remains the same as in the benchmark. In the primary product market, firm G's equilibrium price is determined by the following first-order condition:

$$n_S + (m_s + p_G q_G)\frac{\partial n_S}{\partial m_s} = 0 \rightarrow n_S^* = (m_s^* + p_G^* q_G^*)\frac{\partial F_s(E[U_s])}{\partial E[U_s]}$$

Since the cumulative distribution function F_s must be increasing in seller expected surplus $E[U_s]$, the effect of β_s on seller participation n_S^* depends on its impact on $(m_s^* + p_G^* q_G^*)$. In other words, an increase in β_s will move n_S^* in the same direction as it moves $(m_s^* + p_G^* q_G^*)$.

Recall that firm G's profit is given by $\pi_G^* = (m_s^* + p_G^* q_G^*) n_S^*$. Since an increase in β_s affects $(m_s^* + p_G^* q_G^*)$ and n_S^* in the same direction, we arrive at the same conclusion as in the benchmark: firm G's incentive for self-preferencing aligns with seller participation and their surplus.

As for buyers, their aggregate surplus $E[U_b]$ is determined solely by sellers' distribution between the 1P and 3P services. Thus, the distribution of outside options affects only buyers' absolute level of market participation, not self-preferencing's impact on their surplus.

B.5 Alternative Self-Preferencing Definition

In the main text, we assume that self-preferencing does not affect the total value associated with the 1P and 3P services, i.e., $v_G^s + v_k^s = v^s$. In other words, if self-preferencing increases the value of the 1P service, it results in a corresponding reduction in the value of 3P services. In this section, we relax this assumption, allowing self-preferencing to solely decrease the value of 3P services for sellers without impacting the value of the 1P service.

The alternative definition of self-preferencing does not influence market equilibrium. However, it affects how the 1P service value and market outcome change following self-preferencing. Based on the market equilibrium detailed in Section 2, we first investigate the impact of self-preferencing on social welfare. To do so, we examine how buyers' and sellers' market participation changes following the self-preferencing practice. Now taking the 1P service value v_G^s as exogenously given and to be unaffected by self-preferencing, we calculate the derivative of n_S with respect to β_s:

$$\frac{dn_S}{d\beta_s} = \frac{\beta_s - t}{12t}.$$

As the denominator is always positive, the sign of the derivative is determined by its numerator. Correspondingly, $dn_S/d\beta_s$ is negative if $\beta_s < t$, and it's positive otherwise.

As for buyer participation, its derivative with respect to β_s equals:

$$\frac{dn_B}{d\beta_s} = \frac{\beta_b}{6t}.$$

Therefore, the sign of $dn_B/d\beta_s$ is positive when $\beta_b > 0$, and is the opposite otherwise. We then check how the monopoly firm's profit changes when β_s increases. Calculating the derivation of the firm G's profit with respect to β_s, we derive:

$$\frac{d\pi_G}{d\beta_s} = \frac{(\beta_s - t)(\beta_s^2 - 2\beta_s t + 3t(-3t + 4v_G^s))}{144t^2}.$$

Since the denominator is always positive, the sign of $d\pi_G/d\beta_s$ is determined by the numerator $(\beta_s - t)(\beta_s^2 - 2\beta_s t + 3t(-3t + 4v_G^s))$. Under the assumption that there is positive seller participation, the equation $\beta_s^2 - 2\beta_s t + 3t(-3t + 4v_G^s)$ is always positive. Therefore, $d\pi_G/d\beta_s$ is positive if $\beta_s > t$ and negative otherwise.

Our analysis yields qualitatively similar results to those in the benchmark. First, under the condition that self-preferencing is profitable for the gatekeeper firm, i.e., $\beta_s > t$, self-preferencing is always beneficial to sellers and encourages their entry. Second, self-preferencing practice can either benefit or harm buyers, depending on their preference for 1P versus 3P sellers. Specifically, when buyers dislike 1P sellers and $\beta_b < 0$, self-preferencing makes buyers worse off. Otherwise, it is the opposite.

Comparing this scenario with the benchmark, we find that the gatekeeper has a smaller incentive to practice self-preferencing when it diminishes the total value $v_G^s + v_k^s$ associated with the 1P and 3P services. In this scenario, the gatekeeper is motivated to engage in self-preferencing only when its service value exceeds that of its competitors on the sellers' side. However, in the benchmark, where self-preferencing does not harm the total value $v_G^s + v_k^s$, the gatekeeper can be motivated to practice self-preferencing even if its service value is lower than that of 3P services.

B.6 Market Size

In the benchmark, we assume that all firms in the adjacent market treat the market size as exogenous when choosing their ancillary service prices. In this section, we relax this assumption for the gatekeeper firm. This corresponds to a scenario where the gatekeeper firm has a sufficiently high market share in the adjacent market, such that its pricing strategy for the 1P service has a non-negligible effect on market size. To avoid trivial market equilibria, we make the following assumptions in this section:

Assumption 3. *In Appendix B.6, we assume:*

- ***[Positive Demand]*** *the ancillary service values satisfy $-5t < \beta_s < t$ so that both 1P service and 3P service derive a positive demand at equilibrium; and*

- ***[Competitive Market and Market Participation]*** *the surplus v^s and v_G^b satisfy the conditions such that there exists competition between the 1P service and 3P service, and user entry does not hit corner solution.*

Within this model setup, we proceed to solve for the subgame-perfect equilibrium. The relaxation of the assumption does not affect the transaction stage in the adjacent market. Thus, the demands for ancillary services remain the same as in the benchmark. For the fringe firm k, its profit maximization problem remains unchanged, and its optimal pricing strategy is:

$$p_C = \frac{t + p_G - \beta_s}{2}$$

As for firm G, it earns additional profit from providing the primary product and derives $\pi_G = m_S n_S + p_G Q_G$. Following the same steps as in the benchmark, we calculate seller entry and obtain:

$$n_S = \frac{\beta_s^2 - 2\beta_s p_G + p_G^2 + 6\beta_s t - 16 m_S t - 14 p_G t - 7t^2 + 8tv^s}{16t}.$$

Plugging in the market size and maximizing its profit, the gatekeeper firm adopts the following pricing strategy at equilibrium:

$$\begin{aligned} p_G^* &= \frac{\beta_s - t}{3}, \\ m_S^* &= \frac{18tv^s + 5t^2 - 4t\beta_s - \beta_s^2}{72t}. \end{aligned}$$

Interestingly, when the gatekeeper endogenizes the impact of 1P service price on market size, it is willing to subsidize sellers in the ancillary service market. Accordingly, the equilibrium demands for market participation are given by:

$$\begin{aligned} n_B^* &= v_G^b - \frac{\beta_b(t - \beta_s)}{6t}, \\ n_S^* &= \frac{\beta_s^2 + 4\beta_s t - 5t^2 + 6tv^s}{24t}, \end{aligned}$$

and the equilibrium profit for the gatekeeper firm equals:

$$\pi_G^* = \frac{(\beta_s^2 + 4\beta_s t - 5t^2 + 6tv^s)^2}{576t^2}.$$

To investigate the impact of self-preferencing on market competition, we calculate the derivatives of n_S with respect to β_s and obtain:

$$\begin{aligned} \frac{dn_S}{d\beta_s} &= \frac{\beta_s + 2t}{12t}, \\ \frac{dn_B}{d\beta_s} &= \frac{\beta_b}{6t}. \end{aligned}$$

The analysis gives rise to the same conclusion as in the benchmark. Specifically, sellers derive a higher surplus following self-preferencing when $\beta_s > -2t$ and a lower surplus otherwise. As for buyers, their surplus increases after self-preferencing when $\beta_b > 0$ and decreases otherwise.

Next, we check how firm G's profit changes as β_s increases. Calculating the derivative of firm G's profit with respect to β_s, we derive:

$$\frac{d\pi_G}{d\beta_s} = \frac{(\beta_s + 2t)(\beta_s^2 + 4\beta_s t - 5t^2 + 6tv^s)}{144t^2}.$$

Under Assumption 3, the gatekeeper will find it profitable to engage in self-preferencing when $\beta_s > -2t$. Otherwise, it is the opposite. Combining the results with welfare implication, we derive qualitatively similar conclusions to the benchmark model. When the gatekeeper is motivated to practice self-preferencing, sellers always benefit, while buyers may be either better off or worse off, depending on their preferences for ancillary services.

B.7 Transaction Fee

In the main text, we abstract away the transactions between buyers and sellers, focusing instead on the scenario where both the primary product and ancillary service are charged based on user participation. In this section, we extend the model to examine the transaction stage between buyers and sellers and explore charges on a transaction basis. We highlight that the underlying mechanisms are qualitatively similar to the benchmark. When sellers do not fully internalize buyers' values in their transactions, there can be conflicts between the dominant firm's self-preferencing motivation and its welfare implication. In real markets, such inconsistency between buyers' and sellers' preferences over ancillary services can be caused by various factors, including market uncertainty or a lack of sophistication in buyers' purchasing decisions[30].

[30] A full analysis of user sophistication can be found in Chen and Tsai (2024); Teh and Wright (2022); Bar-Isaac and Shelegia (2022); Johnen and Somogyi (2024); and Decarolis et al. (2025)

This appendix extends the benchmark and is greatly inspired by Apple's self-preferencing in app subscription channels. In the mobile market, sellers are app developers (he/his) who want to sell their application services, and buyers are iOS mobile users (she/her) who want to utility apps. To interact, app developers, such as Spotify, must rely on Apple's App Store to list their apps. Additionally, they need to purchase electronic payment technologies to process users' subscription fees. Apple provides services in both markets. According to the EC, Apple leveraged its monopoly position in the App Store (the primary product) to favor its sale in the electronic payment technology (the ancillary service). Specifically, Apple was found to impose marketing restrictions and prevent app developers from informing users about potentially cheaper subscription channels outside its platform. As a result, the majority of iOS mobile users complete their subscriptions within Apple's system, but at a higher price.

Motivated by this context, we set up the game as follows. There is a normalized size of mobile users and one app developer, such as Spotify. Our analysis focuses on the competition among ancillary services, not among apps. The setup can be seen as a narrowly defined market for a specific app. The timeline is as follows. First, the gatekeeper (Apple) determines the charge for its primary product. As in the benchmark case, the primary product is free for buyers, but sellers must pay. We now allow the primary product charge to be based on transactions and refer to it as a commission fee, d. Next, a competing firm and the gatekeeper (firm G) simultaneously set the prices for ancillary services. Based on the ancillary service price, the app developer determines the price of its final product (subscriptions) sold through the 1P (Apple's) and 3P (non-Apple) channels. Finally, buyers choose a subscription channel and make their purchases. Within this setup, a seller's surplus, U_s, is endogenously determined by the profit from selling the final product to buyers, while a buyer's utility, U_b, depends on both the product's value and its price.

As in the benchmark, a buyer's utility from purchasing through the 1P channel is denoted as v_G^b. If a buyer decides to purchase through the 3P channel, she must incur a search cost of s. This search cost is only realized after she successfully finds the 3P channel and completes the transaction. However, the expected search cost s is public information, denoted as β_b. Hence, the expected utility from using the 3P channel is given by $v_G^b - \beta_b$. Through different channels, buyers may pay different prices. Specifically, p_1^f denotes the price of the final product sold through the 1P channel, and p_3^f denotes the price of the final product sold through the 3P channel. When β_b, buyers expect a higher search cost and sellers are restricted from charging high price through 3P channels. Buyers are heterogeneous in their tastes, and we continue to model this horizontal differentiation using the Hotelling line model. The 1P and 3P subscription channels are located at the two ends of a unit-length Hotelling line, with the 1P channel at 0 and the 3P channel at 1. Buyers are uniformly distributed along this line. They incur the cost of not having their ideal ancillary service that increases linearly with distance at rate t.

To focus on meaningful market equilibrium, we make the following assumptions in this section:

Assumption 4. *In Appendix B.7, we assume:*

- ***[Positive Surplus]*** *the search cost is not too low, such that* $s < \frac{36t^2+72t\beta_b-11\beta_b^2}{12(6t-\beta_b)}$ *to ensure positive buyer surplus; and*
- ***[Positive Demand]*** *the ancillary service values satisfy* $|\beta_b| < 6t$*, ensuring that both 1P and 3P services have positive demand at equilibrium.*

Within this setup, the surplus of buyer j, who purchases the subscription through channel i, is given by:

$$U_b(j,i) = v_i^b - p_i^f - ty(j,i),$$

where v_i^b and p_i^f are the corresponding final product value and price sold through channel i, and $y(j,i)$ is the distance between buyer j and channel i.

Buyers are informed about the 1P and 3P subscription channels and choose the one that maximizes their utility. Specifically, the demand for the two subscription channels can be written as:

$$q_1^f = \frac{(t - p_1^f + p_3^f)}{2t},$$
$$q_3^f = \frac{(t - p_3^f + p_1^f)}{2t},$$

Where q_1^f represents the demand for the 1P channel, and q_3^f represents the demand for the 3P channel.

For each transaction, the developer collects the remaining markup after paying the commission fee and ancillary service cost. Accordingly, the developer's profit from the 1P channel is $\pi_1^f = (p_1^f - d - p_G)q_1^f$ and from the 3P channel is $\pi_3^f = (p_3^f - d - p_C)q_3^f$. At equilibrium, it is profitable for the app developer to coordinate the price such that indifferent buyer between the two channels receive zero surplus from the market. Precisely, the pricing strategy can be written as:

$$p_1^f = \frac{4v_G^b - \beta_b - p_C + p_G - 2t}{4},$$
$$p_3^f = \frac{4v_G^b - 3\beta_b + p_C - p_G - 2t}{4}.$$

We then turn to the ancillary service market. For the competing firm in the adjacent market, its profit comes solely from transactions through the 3P channels, i.e., $\pi_C = p_C q_3^f$. As for the gatekeeper firm G, it charges a commission fee for the primary product and a 1P service charge for each transaction. Hence, its profit is $\pi_G = (p_G + d)q_1^f$. Solving the system of first-order conditions, the 1P and 3P service prices at equilibrium are:

$$
\begin{aligned}
p_G &= \frac{6t + \beta_b}{3}, \\
p_C &= \frac{6t - \beta_b}{3}.
\end{aligned}
$$

Lastly, the gatekeeper firm chooses its commission charge to maximize its profit. Specifically, we find that it is profitable for firm G to continue increasing its commission fee until it extracts all profit from the app developer:

$$d = \frac{\beta_b^2 - 36\beta_b t - 180t^2 + 72tv_G^b}{72t}$$

Accordingly, the equilibrium prices and quantities of subscriptions through the two channels are:

$$
\begin{aligned}
p_1^f &= \frac{12v_G^b - 6t - \beta_b}{12}, \\
p_3^f &= \frac{12v_G^b - 6t - 11\beta_b}{12}, \\
q_1^f &= \frac{1}{2} + \frac{5\beta_b}{6}, \\
q_3^f &= \frac{1}{2} - \frac{5\beta_b}{6}.
\end{aligned}
$$

Our results suggest similar patterns as observed in the mobile markets. When the search cost β_b is high, the final product sold through the 1P channel (Apple subscription channel) is more expensive than that sold through 3P channels (non-Apple subscription channels). Despite the potential for lower subscription fees through 3P channels, the majority of buyers still opt for the 1P subscription channel because of the scaring high expected search costs.

Plugging the final product prices and quantity, we calculate the resulting consumer surplus CS and firm profits:

$$
\begin{aligned}
CS &= \int_0^{q_1^f} (v_G^b - p_1^f - ty)dy + \int_0^{q_3^f} (v_G^b - s - p_3^f - ty)dy \\
&= \frac{-11\beta_b^2 + 36t(-2s+t) + 12\beta_b(s+6t)}{144t}, \\
\pi_G &= \frac{24tv_G^b - 36t^2 - 4t\beta_b + \beta_b^2}{24t}, \\
\pi_C &= \frac{(6t-\beta_b)^2}{36t}.
\end{aligned}
$$

We model self-preferencing as a marginal increase in β_b, which corresponds to an overall increase in buyers' expected difficulty in finding 3P channels. We first examine the gatekeeper firm's motivation for self-preferencing:

$$
\frac{d\pi_G}{d\beta_b} = \frac{\beta_b - 2t}{12t}.
$$

Our analysis indicates that the gatekeeper is motivated to practice self-preferencing only when buyers expect a sufficiently high search cost in finding 3P channels, i.e., $\beta_b > 2t$. We then investigate the impact of self-preferencing on welfare implications. To study, we calculate the derivative of consumer surplus with respect to β_b and obtain:

$$
\frac{dCS}{d\beta_b} = \frac{6s + 36t - 11\beta_b}{72t}.
$$

We derive qualitatively similar conclusions to the benchmark. When the gatekeeper finds it profitable to practice self-preferencing, buyers may either be better off or worse off. Specifically, we find that the practice of self-preferencing increases buyers' surplus if the realized search cost for the 3P channel is sufficiently high, i.e., $s > \frac{11\beta_b - 36t}{6}$. Interestingly, we find that when the realized search cost s equals its expectation β_b, meaning that sellers fully internalize buyers' true value for ancillary services during transactions, buyers benefit from self-preferencing. However, if the search cost is not fully internalized and is much lower than expected, buyers suffer from being steered to the 1P channel through self-preferencing, as they benefit from the lower search cost and product prices available through 3P subscription channels.